World Sustainability Series

Walter Leal Filho
Luciana Brandli
Paula Castro
Julie Newman *Editors*

Handbook of Theory and Practice of Sustainable Development in Higher Education

Volume 1

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Walter Leal Filho · Luciana Brandli
Paula Castro · Julie Newman
Editors

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Editors
Walter Leal Filho
FTZ-ALS
HAW Hamburg
Hamburg
Germany

Luciana Brandli
Faculty of Engineering and Architecture
University of Passo Fundo
Passo Fundo, Rio Grande do Sul
Brazil

Paula Castro
Department of Life Sciences, Centre for Functional Ecology
University of Coimbra
Coimbra
Portugal

Julie Newman
Office of Sustainability
Massachusetts Institute of Technology
Cambridge
USA

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Preface

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

This publication, which consists of a set of 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:

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 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 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 two parts. Part I, under the heading "Sustainability in University Contexts," presents a set of papers which describe a variety of ways via which sustainable development issues are handled in university structures. Many institutions have programs focused on building sustainability leadership skills, with varying designs and skills emphases, but these are hardly ever presented in an integrated way.

Part II focuses on "Implementation of Sustainability in Practice" and outlines examples where sustainability matters have been taken into account and implemented. In this section, readers will have here access to a formidable body of information and knowledge on matters related to the implementation sustainable

development in higher education, which will hopefully be helpful to them, and may inspire further works.

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

Enjoy your reading!

Hamburg, Germany — Walter Leal Filho
Passo Fundo, Brazil — Luciana Brandli
Coimbra, Portugal — Paula Castro
Cambridge, USA — Julie Newman
Winter 2016/2017

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Part I
Sustainability in University Contexts

Inclusion of Sustainability in University Classrooms Through Methodology

Esther García-González, Rocío Jiménez-Fontana, Pilar Azcárate Goded and José M. Cardeñoso

Abstract

The aim of this paper is to presents an analytical instrument (HAMS, in its Spanish acronym), aimed at the study of teaching methods and the inclusion of Education for Sustainable Development (ESD) in university classrooms. HAMS is based on a review of studies focused on this field, and the process of developing had revealed methodological strategies in this regard. The focus of HAMS is the study of teaching and decision making in university classrooms, at both planning and intervention levels. Its development is part of a study that analyses the methodological strategies from the perspective of the values of ESD, and on the basis of the principles of complexity. HAMS should be useful for university teachers when analysing and reflecting on their teaching practice. Also, HAMS may be of use to university authorities to detect obstacles in the performance of their instructors, and to plan and design activities that allow for the inclusion of ESD in their centres. This activity has been identified as one of the priority areas for action in higher education because of its direct impact on the formation of future professionals.

E. García-González (✉) · R. Jiménez-Fontana · P. Azcárate Goded · J.M. Cardeñoso
Department of Education, University of Cádiz, Research Group HUM 462 "Teachers' Professional Development", Cádiz, Spain
e-mail: esther.garcia@uca.es

R. Jiménez-Fontana
e-mail: rocio.fontana@uca.es

P. Azcárate Goded
e-mail: pilar.azcarate@uca.es

J.M. Cardeñoso
e-mail: josemaria.cardenoso@uca.es

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Keywords
University teachers · Education for sustainability · Teaching methods · Complexity

1 Introduction

This study arose from the need for changes to be made in society and in society's relationship with the environment, in order to improve the current worldwide situation of crisis. It is urgent for steps to be taken towards a change in mentality and beliefs, as well as in institutional and individual values and actions. And such steps need to be led by our universities (Leal Filho 2009) since the university is responsible for training professionals who will be faced with solving the systemic problems that we are suffering. One of the criticisms made of ESD is the lack of methodological proposals for the university context. Among the reasons for this situation is the difficulty to institutionalize sustainability in higher education, as this would require an organizational restructuring of the university educational system (Tilbury et al. 2004). The very transdimensional nature of sustainability may hinder its translation to an educational praxis. From a complexity and sustainability point of view, it is essential to insist on the need for educational innovation that includes sustainability with approaches that facilitate interdisciplinary thinking (Warburton 2003).

We believe that the inclusion of sustainability must begin in university classrooms (Cebrián et al. 2014). These can be scenarios for change, provided that the instructor develops holistic teaching and learning methods. These practices should promote the formulation of socio-environmental problems, and encourage critical reflection and the exchange of information and ideas. In short, they should generate divergent and creative thinking in the search for solutions. The purpose of the study carried out was to characterize the methodological strategies for the inclusion of ESD in university classrooms.

As referents, we took the studies of the Network for Greening the Curriculum (Junyent et al. 2003) and of Cardeñoso et al. (2013). In our study, the instructor is considered to be the main dynamizing agent of the process. It also considers a series of methodological elements which favour the inclusion of principles of sustainability in classes. The combination of these two aspects at different levels of complexity, and their interaction with the agents that make up the class—the students and the content—can be a way to orient the inclusion of sustainability in the university context. The characterization of these methodological strategies and their contrast with empirical data have led to the development of an instrument for the analysis and self-analysis of teaching practice from the perspective of the principles of sustainability and complexity.

2 Education for Sustainable Development, and Teaching Methods in the University

One of the objectives of ESD is to form professionals who are able to deal ethically and responsibly with the socio-environmental conflicts that they will encounter in the exercise of their profession (Azcárate et al. 2012). In this sense, progress has been detected in different areas of knowledge regarding the integration of sustainability in universities. But it is necessary to go into greater depth in proposals that show the real changes that this integration may lead to (Leal Filho 2011). It is still a challenge to include sustainability in a broad and holistic sense (Jones et al. 2010).

To advance in this integration, it is necessary to initiate changes in university classes for these to become the generating nuclei of a culture of sustainability. This will be possible through, among other routes, the implementation of methodological strategies that are in line with the principles that promote sustainability: the principles of ethics, holism, complexity, globalization, mainstreaming, and social responsibility in the university (C.A.D.E.P.-C.R.U.E. 2012). Reflecting these principles in the classroom requires a methodological organization, structure, and functioning that facilitate them. Classes should also be permeable to other complementary actions and proposals that filter down from other levels of the institution and society (Wiek et al. 2014). This may then spread to inundating the rest of the university, and thence to society in general. Instructors, students, and content are the elements of flux that extend out to other foci such as educational programs, the faculty in general, and the university community, and vice versa, fostering dialectic interaction in different directions. Thus, with the university as referent in the creation of scientific and human knowledge, sustainability may then be transferred to the rest of society (Fig. 1).

ESD provides educational bases on which to design methods that foster critical and creative thinking, competencies, and decision making and problem solving capacities (UNESCO 2014). This is always from a cross-disciplinary perspective (Lozano et al. 2013).

In this study we propose a transformation of the form of teaching which involves an in-depth rearrangement of its epistemological presuppositions (Sterling and Thomas 2006). In particular we understand the knowledge the teacher develops in the classroom as being instrumental so as to address socio-environmental problems and promote the development of the competencies necessary for sustainability (Rivero et al. 2011).

The methods that we shall present are extendable to all university classrooms because of their open character. They can be adapted to the particularities of each discipline. The objective is not only for the students to be able to propose effective technical solutions, but for them also to understand the depth and scope of socio-environmental problems and to analyse them critically (Thomas 2009), in order to be able to act accordingly in the development of their profession.

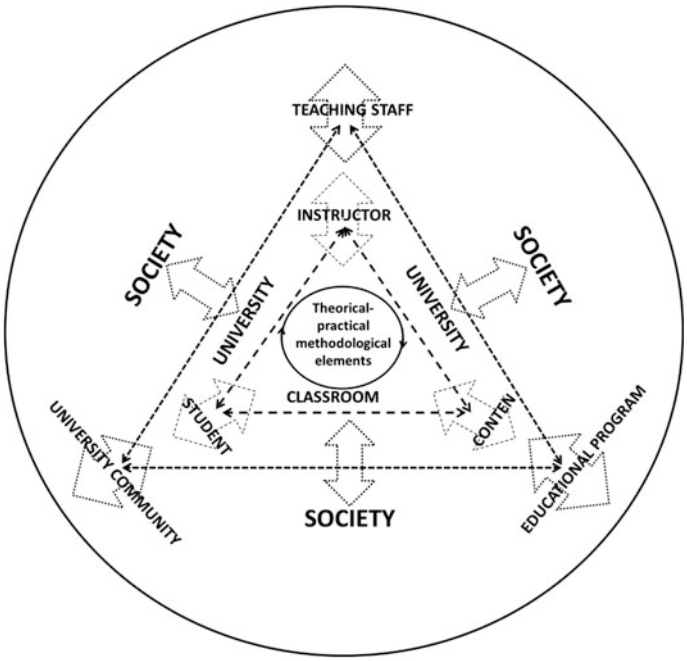

Fig. 1 University classroom system and its interaction with the social environment. *Source* The authors

Our methods respect the complexity of the processes of teaching and learning. They take into account the coexistence in the classroom of ideas that are mutually exclusive, but are inseparable and complementary (Morin 2008). They are articulated through the dialogue between theory and practice, as reflected in the two levels of educational action—planning and intervention. In both, there coexist various characteristic methodological elements, defined through two opposite extremes that interact with the three agents involved—instructor, student, and content—thus configuring educational action. The treatment in the classroom of these methodological elements, and their implementation in actions consistent with sustainability, allow the two levels and their reflection in the different agents involved to be characterized (García-González et al. 2015). These methodological elements are:

- *Teacher-student relationship: Vertical↔Horizontal*

The vertical perspective takes the instructor to be responsible for the teaching and learning process. The horizontal one gives each individual an active role in the process (Viladot and Pedreira 2012). The integration of sustainability configures a process in which the instructor acts as the mediator bringing into play the tools for

learning, and in which the responsibility for what happens in the classroom is shared between the students and the instructor.

- *Competencies: Specific↔Transversal*

The competencies for sustainability should enable the individual to cope with socio-environmental problems, and prepare students to make complex assessments of their own work and of that of others, and to make decisions in the unpredictable circumstances that they will encounter in the future (Wiek et al. 2011). A specific competency defines the concepts to be learnt, and a transversal competency links the content with the surrounding medium. Sustainability allows the two types of competencies to be integrated.

- *Socio-environmental reality: Unintegrated↔Integrated*

In our classes, involving the socio-environmental reality with which we interact fosters the students' autonomy, responsibility, and capacity for commitment. It shows that knowledge can be approached from different directions, and that there are various ways to solve any given problem. Bridges need to be built between this reality and knowledge of the discipline, facilitating the systemic and cross-disciplinary perspective of sustainability (Wals and Jickling 2002).

- *Resources: Internal↔External*

It is necessary to combine the use of internal resources, whose function is to organize the teaching and learning process, with the use of resources existing in our environment (dialogue with experts, field trips, direct interventions, addressing socio-environmental problems, practice in specific centres, …). The aim is for the environment to enter the classroom (Wiek et al. 2014) and for this to get out of the university. The aim is to make use of all the resources available to us, enhancing the synergies that arise when they are put together in order to promote sustainability.

- *Evaluation: Accreditation↔Procedural*

Accreditation evaluation is a final assessment, guaranteeing to society what has been learnt. Procedural evaluation covers information about the process and the participants, and the results have an impact on both, allowing for improvements to be made to the process (Sanmartí 2007). It takes account of cognitive, affective, and action aspects. The two functions are complementary. One is required by the legal context, and the other to regulate teaching and learning. Evaluation understood as reflection, valuing, and an element for improvement is an essential component for students to cope with the complexities posed by the socio-environmental problems that they will face in their daily lives and in their working environment.

- *Classroom dynamics: Closed↔Open*

Closed dynamics are needed to put order into ideas, to settle bases, and to provide orientation. They should alternate with open dynamics that allow the inclusion of new content, areas of interest, or problems. The teacher should encourage the formulation of questions, offer new insights, and highlight curiosity as a stimulus to building knowledge (Bonil and Soler 2012). A classroom dynamics consistent with the principles and values of sustainability means giving voice to the students so that they can negotiate and take sides in class. The idea is for them to make decisions independently—decisions that are informed and responsible.

- *Class work: Individual↔Group*

The contrast between individual and group class work causes cognitive conflict (Coll 1994). This leads to reflection on and restructuring of ideas, making learning possible through active dialogue with the rest of the group and then solidification through personal reconstruction. The synergy between the two strategies endows the learning with meaning. From the perspective of sustainability, this combination promotes the integral formation of the individual, recreating situations that the students will encounter during their professional and personal lives. The focus is on the responsibility of group work, communication, strategies for learning, criticizing, and addressing knowledge through negotiation of meanings.

From the combination of these methodological elements in their implementation in class and their interaction with the agents of the teacher, students, and content, there will emerge the approximation of these practices to the principles of sustainability. The goal is to form agents of change—students who understand the scope of the socio-environmental crisis, able to transform their reality by constructing a sustainable environment through their profession and their active involvement in society.

3 HAMS: A Tool for Methodological Analysis from a Sustainability Perspective

From theoretical background, we have developed a qualitative research, and it has led to develop a tool for methodological analysis from a sustainability perspective (HAMS, in its Spanish acronym). We have been done a case study. In this case study we analyse teaching practices from a perspective of the principles of ESD. We have selected three teachers of different knowledge areas: education, environmental science and economical science.

The data was collected through questionnaires, interviews and video recordings of the lessons. We constructed the tool HAMS, a system of categories on the basis of the aforecited theoretical referents for the qualitative data analysis. The design of HAMS are based in a validation process (Litwin 1995). This had four stages. Phase 1, we constructed the system only from theoretical referents. Phase 2, the system was subjected to a procedure of validation by experts in sustainability and university education. Phase 3, we have analysed the system in our research group and finally in the phase 4 we contrasted the system with the data.

HAMS takes the classroom to be a complex system, allowing how it functions to be analysed as a set of interactions between its component parts (Jiménez-Fontana et al. 2015). These relate to the three agents, teacher, students, and content, in their interaction with the methodological strategies put into play at both the planning and the intervention levels. All of these—agents, strategies, and levels—become the dimensions for analysis.

The methodological strategies described above move between the two extremes which define them, offering a broad set of possibilities corresponding to the decisions the teacher might make on how to implement them in class. In HAMS, we have included these possibilities as indicators, in gradients ranging from simple states in which there is no presence of sustainability to complex states in which it forms an integral part. There are three types of gradient: Gradient 1, containing five indicators; Gradient 2 with four; and Gradient 3 with three indicators. They are all functions of the characteristics necessary to describe the methodological element in question. The highest numbers of the indicators correspond to the states of greatest integration of sustainability. This case would be the most complex, and requires a balanced integration of the two extremes of the methodological element. The more complex, elaborate, and reflective the teaching practices, the more they would favour the inclusion of sustainability since they will be more in tune with the principles it promotes.

Tables 1, 2 and 3 present the HAMS instrument, differentiating it for the three agents that make up the system of the classroom—teacher, student, and content. The two levels of planning and intervention are considered, within which we include the different methodological strategies with their corresponding indicator gradients.

Knowing to what extent the teaching practices we employ promote the presence of sustainability in our classes requires a view of all the aspects reflected in HAMS. One can only understand a process of teaching and learning through the interactions and synergies that arise in joining agents and methodological strategies together.

Applying HAMS to teaching practice will not only serve to determine the extent to which sustainability is present in our classrooms, but also to point to possible actions that may help make advances in this direction, since the indicators are specified in actions that favour that purpose.

Table 1 The main dialogic axis, secondary dialogic axes, and indicators for the teacher as agent

Teacher		
Main dialogic axis	Secondary dialogic axes	Indicators
Planning	Teacher-student relationship, Vertical↔Horizontal	1. In the planned methods of working, the teacher is the principal agent of the process 2. In the planning, the students are granted a certain role, but it is the teacher who calls the tune 3. The methodological plan reflects the participation of all the agents in the process of teaching and learning
	Competencies, Specific↔Transversal	1. All the competencies are formulated in specific terms linked to the subject 2. The specific competencies linked to the subject are maintained and some new transversal competencies are formulated 3. The competencies are formulated in comprehensive terms, with a confluence of the specific and the transversal competencies
	Socio-environmental reality, Unintegrated↔Integrated	1. The socio-environmental reality does not appear in the planning of the course 2. There are some allusions to the socio-environmental reality 3. Clear indications are made to the socio-environmental reality, although in a parallel form 4. The socio-environmental reality is the hub around which the course is planned and designed
	Resources, Internal↔External	1. In the planning, reference is made only to resources of the internal context: seminars, laboratory, ICTs, library, … 2. Apart from common resources of an internal context, the planning also alludes to the use of some other resources linked to the environment 3. The environment is regarded as a fundamental resource in the teaching and learning process
	Evaluation, Accreditation↔Procedural	1. The planned evaluation focuses only on the student, and uses tests or examinations at the end of the process 2. More than one assessment instrument is planned, during or at the end of the process, but they are only targeted at the students 3. Evaluation appears in the planning at different times, using different instruments and sources of information 4. Evaluation is considered in the planning at different times, using different instruments and sources of information, and regulating all the elements of the process

(continued)

Table 1 (continued)

Teacher		
Main dialogic axis	Secondary dialogic axes	Indicators
Intervention	Teacher-student relationship, Vertical↔Horizontal	1. The teacher is the only agent choosing and directing the teaching and learning process 2. The student acquires a certain role in the teaching and learning process, but it is the teacher who directs and leads it 3. The teacher brings into play a process of teaching and learning considering new content and concerns that are worked on temporarily, without substantially changing the original planning 4. The teacher's reactions to contributions from the students facilitate their participation, and they acquire a greater role 5. The teacher acts as a mediator/facilitator in the teaching and learning process, so that the dynamics of the class are open to all participants
	Competencies, Specific↔Transversal	1. The teacher does not refer to the role as agents of change that the students have, and will have as future professionals of the discipline they are studying 2. There are hints, but not direct or clear, about the students' engagement with the development of their profession 3. References are made to the problem-solving responsibility that the students will have as professionals
	Socio-environmental reality, Unintegrated↔Integrated	1. The discourse does not include the socio-environmental reality, but is restricted to the topics of the subject being taught 2. The discourse includes some socio-environmental aspects, but preferentially linked to the dimension nearest the discipline, without addressing the interactions between all the dimensions involved 3. The discourse promotes civic values and social participation, addressing possible social, economic, and environmental interrelationships 4. Different ethical positions on the socio-environmental reality are brought into play and analysed 5. Environmental, social, and economic interrelationships are addressed; contributions from different disciplines and other fields of knowledge are included from an interdisciplinary or multidisciplinary perspective
	Resources, Internal↔External	1. The classes are developed with the use of resources from the internal context, with no regard to the external context 2. Reference is made to the existence of external resources, but as mere information to be considered 3. The possibilities of intervention in environmental issues is openly admitted, but without encouraging active participation

(continued)

Table 1 (continued)

Teacher		
Main dialogic axis	Secondary dialogic axes	Indicators
		4. Involvement in local socio-environmental problems is promoted and encouraged 5. Internal and external resources are used indistinctly and conjointly, encouraging interaction with the environment
	Evaluation, Accreditation↔Procedural	1. The student is evaluated through partial or final tests or examinations 2. As well as examinations, use is also made of individual work, class participation, involvement, etc., but with a focus only on the student 3. Different evaluation elements are used by the teacher, and the student's self-assessment and co-assessment at different stages of the process are also taken into account 4. Evaluation takes place throughout the process, with different instruments, and with the participation of both the teacher and the student; the information obtained influences the course of the process
	Classroom dynamics, Closed↔Open	1. The questions/strategies used have a single answer 2. Although different answers to the questions posed are valued, only that foreseen by the teacher is considered correct 3. Questions/strategies are formulated as a means to learn what interests the students, to refocus the activity, and to present other information 4. Divergent and diverse responses to the same question/strategy are encouraged and valued without there being any single foreseen answer
	Class work, Individual↔Group	1. The student in class only takes notes and then prepares individually for the tests or final examinations, without interacting with peers 2. Unidirectional and vertical class participation is facilitated 3. Both individual and group work in class and outside, encouraging teamwork. The interests of the whole class and the individual are taken into account 4. The work is organized in cooperation among the participants, with decisions having to be made as a collective, but coordinated with individual dynamics

Source The authors

Table 2 The main dialogic axis, secondary dialogic axes, and indicators for the student as agent

Student		
Main dialogic axis	Secondary dialogic axes	Indicators
Planning	Teacher-student relationship, Vertical↔Horizontal	1. In the planning of the course, there is no space allowed for students' contributions 2. Students and their interests appear as an element to consider, but they do not have the principal role in the teaching and learning process, which instead is led by the teacher 3. In the planning, reference is made to the involvement and active participation of the students in the process of teaching and learning, with the possibility of them making decisions
	Competencies, Specific↔Transversal	1. The competencies of the course are focused on developing the capacities of the subject in accordance with the official curriculum of the degree 2. In the competencies of the course, some reference is made to the students' role as professionals, but without any clear linkage with the results of learning 3. In addition to the particular competencies corresponding to the subject, there is included the formation of professionals with a commitment to improving their environment and of citizens who are critical and autonomous
	Socio-environmental reality, Unintegrated↔Integrated	1. In the planning, the socio-environmental reality is not linked with the students' future role as professionals 2. Some relationships are made between the socio-environmental reality and the students' future role as professionals 3. The socio-environmental reality is considered to be a pillar of the formation of the students for their professional development
Intervention	Teacher-student relationship, Vertical↔Horizontal	1. The participation of students is directed and mediated by the teacher 2. The students are involved and participate spontaneously in the development of classes, without waiting for the teacher's invitation to do so 3. The students can express their views on the process, but it is the teacher who makes the final decision 4. The students actively participate in the process, but instead of encouraging them going into greater depth in this participation, the class is led back to the initial planning 5. The participation of the students is part of the actual teaching and learning process, with their taking the principal role in the process and the teacher being a mediator; democratic participation in conflict resolution and classroom decision-making is promoted

(continued)

Table 2 (continued)

Student		
Main dialogic axis	Secondary dialogic axes	Indicators
	Socio-environmental reality, Unintegrated↔Integrated	1. The socio-environmental reality is not reflected in the development of the classes, and therefore is not linked with the students' future professional role 2. The socio-environmental reality is sometimes linked with the students' future professional role 3. The socio-environmental reality is inherent in the role and professional development of the students, as is manifest in the classes (through discourse, activities, …)
	Classroom dynamics, Closed↔Open	1. No account is taken of the students' interests and concerns, only the initial planning 2. The students' interests are attended to, allowing time for reflection, but the proposals are not developed further 3. Students' proposals in relation to the formulation and treatment of problems, cross-cutting content, activities, etc., are taken up; the process is reorganized, and reflection on and analysis of the proposals is promoted in the dynamics of the class
	Class work, Individual↔Group	1. Individual work in class is the most widely used resource; group work is not part of the methodological strategies 2. Group work is sporadic; it is an insignificant methodological resource 3. Group work is significant and plays an important role in the process 4. Cooperative work is combined with individual work in the development of the classes, and both are significant in the teaching and learning process

Source The authors

The process of developing of HAMS has triggered profound reflections throughout the entire investigation inherent to the qualitative research methodology.

Specifically, the different types of gradient have hindered the analysis of data. In addition, the results for each one of the three agents that make up the system of the classroom—teacher, student, and content, cannot be considered separately. Any action in the classroom is associated with the interactions between three agents. These interactions show the level of inclusion of sustainability in the teaching-learning process. This question has constrained data analysis process and the interpretation of the achieved results.

Table 3 The main dialogic axis, secondary dialogic axes, and indicators for the teacher as agent

Content		
Main dialogic axis	Secondary dialogic axes	Indicators
Planning	Teacher-student relationship, Vertical↔Horizontal	1. The content is presented in a closed form, organized by topics that match the organization of the discipline 2. The content is grouped into thematic units, and these are the main objective of the process, but small spaces are allowed for the treatment of other content of interest 3. The content has a common thread, it is not set in stone but is open to the incorporation of new topics arising in the teaching and learning process 4. The content has a common thread that responds to the resolution of problems proposed in class; it is not an end in itself, but is open to the incorporation of new topics 5. Apart from not being an end in itself, from having a common thread, from responding to the resolution of problems, and from being open to the incorporation of new topics, the content also incorporates the strategies developed in the teaching and learning process
	Competencies, Specific↔Transversal	1. The competencies only refer to the use of the knowledge and content corresponding to the subject 2. The competencies interrelate different types of knowledge 3. In the planning, the development of transversal competencies is introduced as part of the knowledge
	Socio-environmental reality, Unintegrated↔Integrated	1. The content is limited to that which is specific to the subject and included in the official curriculum of the degree 2. The subject's content contains some issues or aspects relating to the socio-environmental reality 3. The socio-environmental reality has a constant presence in the subject's content 4. The socio-environmental reality acts as the hub around which the course is designed
	Evaluation, Accreditation↔Procedural	1. The planned evaluation focuses on conceptual knowledge and on the student 2. The planned evaluation considers some other aspects of the teaching and learning process in addition to knowledge, but its focus is only on the student 3. The planned evaluation takes into account all elements of the teaching and learning process; also, the programming specifies the evaluation criteria

(continued)

Table 3 (continued)

Content		
Main dialogic axis	Secondary dialogic axes	Indicators
Intervention	Teacher-student relationship, Vertical↔Horizontal	1. In class, the programmed content is worked on in a linear and systematic form, setting the pattern of the class dynamics 2. The content is treated systematically, but it is also worked on as providing tools for solving situations and finding information 3. The content in class is at the service of solving problems, and itself becomes a resource
	Socio-environmental reality, Unintegrated↔Integrated	1. When the content is covered, only knowledge corresponding to the subject is worked on 2. In addition to knowledge corresponding to the subject, aspects that do not strictly correspond to the discipline and with reference to the socio-environmental reality are dealt with sporadically 3. Knowledge from other areas or disciplines is addressed transversally in a form underlain and articulated by the socio-environmental reality
	Resources, Internal↔External	1. No socio-environmental issues are used to address the content 2. Reference is made to such issues, but they are not used as a resource with which to work on the content 3. Real cases are used in which to involve the content, making references to current issues (the content is thereby given applicability)
	Classroom dynamics, Closed↔Open	1. The questions/strategies used in class are final, and seek only to reaffirm the content being taught 2. New questions are opened to encourage the students' reflection, but their responses are not used as a strategy to approach the content 3. The questions/strategies formulated are open, with a dynamics in which the responses themselves become content, and are further enhanced and built on

4 Conclusions

We must move towards models of the university that promote a harmonious relationship between society and the biosphere, and which form citizens and professionals capable of meeting this challenge. For this, it is necessary to include ESD in university classes through using methods that favour its principles. The research conducted has led to identify some methodological strategies as a possible way to work towards this end.

However, we assume that the path for this inclusion is not generalizable, but instead demands inquiry, reflection, and experimentation appropriate for the process in each specific case. It is not a proposal for immediate and final implementation, but part of a long-term constructive process. Our goal is to provide keys, to put forward a starting point from which each teacher can construct their own personal and transitory route which will increase in complexity as they progress in integrating sustainability in their classes. To help with this process, we presented HAMS, a system of categories for data analysis, which may be of use to analyse and reflect on teaching practice. It is a powerful means of methodological self-diagnosis for teachers interested in this area, since it lets them detect their own actions and decisions, and offers them options that can foster an appropriate ESD.

We believe in the future HAMS can also serve as a tool with which to analyse the curricula of institutions of higher education, and to determine the degree to which they include sustainability. It can also be a means of support for university authorities to plan and design educational activities that result in improving the impact of sustainability in their institutions. HAMS can begin a transition road from a simplifying view of action in the classroom to a complex view which is in accordance with the principles and values of sustainability (Wals and Jickling 2002).

To conclude, we believe that both HAMS and the methodological strategies can serve to inspire the adoption of similar approaches, and for the university community to share methodological practices that can contribute to extending the culture of sustainability. Assisting university teaching staff to recognize their actions and the possible changes they might make in their practices is a real way to achieve systemic changes (Barth and Rieckmann 2012). They are the ones who can act as facilitators of learning for ESD, and therefore equip their students with the competencies that they in turn will need to contribute to sustainable development.

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Authors Biography

Professor Esther García-González is graduated in Ocean Sciences (2007), master's degree in Environmental Education (2011) and Ph.D. in Education for Sustainability (2016). She is currently Professor in the University of Cádiz (Spain) working in degree of Primary School and Early Childhood Education and in Masters of Environmental Education and Educational Research for Teacher Professional Development. Her current research interests include sustainability in high education, curricular sustainability, evaluation systems in the classroom consistent with sustainability and teacher training.

Professor Rocío Jiménez-Fontana is graduated in Environmental Sciences (2009), master's degree in Environmental Education (2011), master's degree in Teaching Secondary Education (2012) and Ph.D. in Education for Sustainability (2016). She is currently Professor in the University of Cádiz, south of Spain, working in degree of Primary School Teacher and in Masters of Environmental Education, Teaching Secondary School and Educational Research for Teacher Professional Development. Her current research interests include sustainability in high education, curricular sustainability, evaluation systems in the classroom consistent with sustainability and teacher training.

Professor Pilar Azcárate Goded has a degree in Physical sciences at University of Sevilla (1977), obtained his Ph.D. in Philosophy and Education Sciences from the University of Cádiz, Spain, in 1995. She is professor and researcher in this University. His current research interests include teacher education, statistic education, assessment and methodology in Mathematics Education and Education for Sustainable Development.

Professor José M. Cardeñoso B.Sc. Mathematics, specializing in Teaching Methodology and the Complutense University of Madrid, Spain, 1981. Author of textbooks for Mathematics and Primary Education, Development Reform 1981/82. Master of Science and Mathematics in Primary Education in contexts of New School 1982/84. University Professor of Mathematics Education Area at the University of Granada, 1984/2010. University Professor of Mathematics Education Area at the University of Cádiz, 2010/2016. Research Group founder PAI Andalusia, Hum462, Teacher Professional Development, attached to the UCA in 1994. Doctor of Philosophy and Educational Sciences from the University of Cádiz, 1998. Director of research Professor active and training and Azar, Randomness and Probability and Stochastic Field organizing notions as fundamental line. Currently he supplemented with Research Project of Sustainability Curriculum in Teacher Training.

Controlling Risks Through Flexibility and Urban Integration: The Regeneration of Otaniemi Campus in Finland

Antti Ahlava, Jarmo Suominen and Saana Rossi

Abstract

Aligning Aalto University's scientific and economic potential and risk management with the growing Otaniemi campus takes place with flexible and integrative spatial and urban concepts. The campus development wants to maximize the usages of existing resources, optimize the flexibility of uses and minimize fixed costs of users for changing future as well as to produce urban, street-level places for enhanced social encounters and open innovation. This living laboratory of campus development aims at flexibility also in energy production, as well as at increasing self-sufficiency, made possible by local energy solutions, a smart utilization of electricity network and by changing consumer behaviour. The new internal service operator role for renting relevant resources has diminished surplus areas of academic units and the freed spaces are treated as shared resources for work, housing and services according to the principle of Building as a Service (BaaS). New types of gardens support biodiversity cycles. The university has also implemented on-demand public transportation service supporting flexible mobility to other campuses. The campus sustainability programme connects the university with external partners, such as industry, government, and various organisations of civil society. Through this

A. Ahlava (✉) · J. Suominen · S. Rossi
Department of Architecture, Aalto University, 00076 Aalto, Finland
e-mail: antti.ahlava@aalto.fi
URL: http://www.aalto.fi; http://www.groupxaalto.fi

J. Suominen
e-mail: jarmo.suominen@aalto.fi

S. Rossi
e-mail: saana.rossi@aalto.fi

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multi-faceted development, the mono-functional green-field campus receives company from a new diversified city with mixed-use urban development. Partnering is crucial, contributing to sharing economical risk, social and humanitarian programs, sustainability networks, city partnerships, greening events, and cross-disciplinary academic programs. Along the philosophy of BaaS, companies and partnering research institutions are welcome to locate their personnel to the thematic quarters of the campus, supporting co-creation and empowering the culture-economic ecosystem.

Keywords
Service architecture · Building as a service · Sustainability · Participatory design · Partnering

1 Introduction: Addressing Environmental, Field-Specific and Economic Resiliency

Even if the focus in urban risk management has conventionally been in preventing natural catastrophes and diminishing their damage (see e.g. Coyle 2011, or Serre et al. 2012), urban development and regeneration can also cause risks for urban heritage and local urban economies. The risks linked to the growing campus of Aalto University in Otaniemi area, are related to (a) to the difficulty of moving the locally rooted vitality of the two shrinking campuses from elsewhere to the growing campus in Otaniemi, (b) the threat to the natural and cultural environment in global and local perspective and (c) the economic challenges caused by the diminishing government funding for the university.

When Aalto University was created, it was a merger of three leading universities in the country in the fields of technology, economics and design. All of these former universities established in the 19th century had their own campuses, but in the year 2011 the Board of Aalto University Foundation decided to concentrate the activities of the joint university to the former Helsinki University of Technology campus in Otaniemi, also promoted nowadays as Aalto City. The motivation behind this decision was to support interdisciplinary collaboration. The economy campus in Töölö at the centre of Helsinki and the art and design campus in Arabia had developed their own local, well-rooted and functional ecosystems with accompanying business and research partners, research and post-professional education institutions, and even with retail. Now the task of the campus development of Aalto University is to relocate not only these academic units to Otaniemi, but also trying to attract their symbiotic partners—the whole ecosystems of urban life and contextual economy—to join the move to Otaniemi campus, formerly known merely as

a sub-urban satellite-type technology campus (Hoeger and Christiaanse 2007, 268–271). In order to support field-specific diversity and to help to re-root the micro-cultures, the regeneration of Otaniemi has had the purpose of thematic development of the sub-areas of Aalto City in order to catalyse local economies and cultures. The university welcomes partners to locate their units and personnel in shared buildings on campus, and develops shared premises for open innovation. The main motivation behind this principle of land-use and locating activities has been to foster scientific research and cross-disciplinary theme-based collaboration, but there are benefits for the urban life as well.

The campus development of Aalto University aims also at flexibility in energy production, as well as increasing self-sufficiency, made possible by local energy solutions, a smart utilization of electricity network and by changing consumer behaviour. Aalto University collaborates with energy companies St1 and Fortum for example in an experimental five miles deep geothermal 10 MW plant (St1 2015), producing possibly all of the hot water of the campus in the future, adding resilience through independency (Fig. 1).

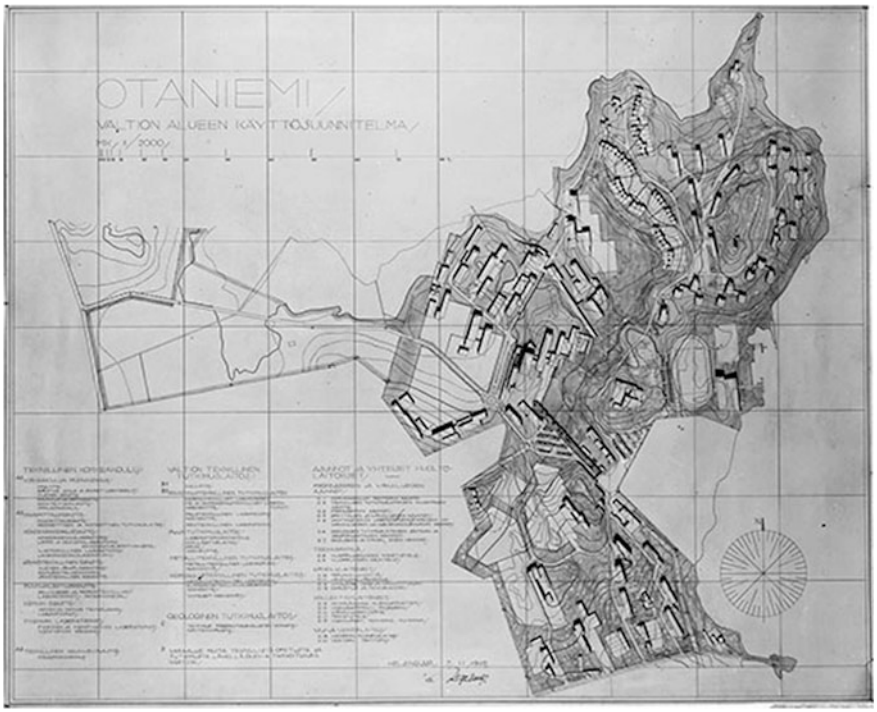


Fig. 1 Alvar Aalto: Land Use Plan, Otaniemi, November 7th, 1949. Copyright Aalto University Archives

2 The Cultural Heritage of Otaniemi

One risk, caused by the removals to Otaniemi, is the threat the new urban development brings to the heritage of the area. There are remarkable architectural and natural values possibly at threat. The original city plan of Otaniemi area was made by the acclaimed architect Alvar Aalto and many of the buildings at the core of the campus have been designed by him as well. This risk has been treated in collaboration with the Finnish National Board of Antiquities (NBA) (2016), which has declared the core area of the campus as protected cultural environment. The university is collaborating with the NBA in order to maintain cultural and architectural values of the core, as well as to take these into account in the development of the adjacent land. Changes in the area been monitored and supported by a constant dialogue with the NBA, municipal planning authority and Alvar Aalto Foundation, as well as by using high profile architectural competitions in the development of the area.

A parallel risk stemming from the cultural heritage of Otaniemi is that the protection of the cultural environment might hinder campus development. Buildings with long corridors lined with small offices and lecture halls are ill suited for highly mobile and collaborative group work. According to a recent facility satisfaction survey conducted at Aalto University, over half of the staff preferred multi-functional group working spaces over individual offices (ACRE 2015a). Work and studies are increasingly dependent on computer use, but most lecture halls don't have enough electrical outlets or table space for laptops. According to Aura Kivilaakso from the NBA, however, it is critical for the conservation of protected buildings that they remain in active use, and thus they also have to adapt to changes in the needs of the users and technical requirements (2010).

The old main building of the University of Technology, nowadays called the Undergraduate Centre, and Library Building—both designed by Alvar Aalto—have been challenging to renovate due to their protected status (Wallin and Staffans 2015; ACRE 2015b). The addition of non-permanent structures has allowed, however, to turn both buildings more accessible, and new meeting and group work spaces have been created by furnishing previously empty hall spaces and creating "learning hubs" (self-steered spaces for individual students and their group work) in suitable areas (Rytkönen et al. 2015).

3 Natural Environment

Regarding the global scale environmental sustainability—lower energy use and less CO_2 emissions—the university aims at a smart utilization of electricity network in producing and storing electricity with local energy companies and network providers and by changing consumer behaviour through cross-disciplinary education, sustainable entrepreneurship, greening events, optimised and shared use and smart mobility (Aalto University 2016).

In local scale, the crucial prerequisite is that Otaniemi campus is located next to a natural preservation area in Laajalahti bay of Baltic Sea. Laajalahti is one of the key bird reservoirs in the metropolitan region (Parks and Wildlife Finland 2016). The risk that new development would threaten the nature reserve has been eliminated by thorough environmental assessments as part of the planning processes. This concerns for example distances of construction from the border of the reserve and building heights.

However, there is also an opportunity for experiments in architecture, while as simultaneously supporting the diversity of the nature. One example of this is the recent design for a new housing area by the coastline near the nature reserve. The buildings are clad with a wooden grille structure, where the protected flying Russian squirrels can live (Europan 2016).

The Decaying Gardens produced by Aalto University and Helsinki University are supporting biodiversity cycles and there is also a popular new allotment garden at the university campus. The university has also implemented so-called Kutsuplus on-demand mass transportation service enhancing flexible mobility to other campuses.

4 Flexibility and Changeability as Economic Guarantee

The government of Finland has repeatedly cut university public funding and the similar funding in Europe is in general economic problems at the moment. However, improving urban areas in economically unstable circumstances can be supported by socio-economic diversity (Cooper et al. 2009). The opposite of this diversity is actually how the core of Otaniemi campus—designed by Alvar Aalto—is based on low degree mixing of users and user groups and, one could argue that there is a strong sense of formalism instead: the original plan from 1949 is based on concentrating buildings and roads on forested hills and ridges, while light traffic takes place on the lawns of lower fields. In the area produced by this original campus plan, the distances between different uses and user groups are huge, supporting private car traffic. In order to increase local cultural and economic diversity, the networks and life of a campus can be supported by an adaptable spatial network, which supports collaborative culture (ibid.). Network typology is changing from the decentralized, department-based solution to a distributed and more integrated structure. It is required that new connecting nodes are identified and developed.

By using contemporary terminology of urban design, the urban regeneration of Otaniemi could move from a field condition (Allen 1999) of an anonymous matrix of figure (buildings) and ground (nature) towards a model, which is more user and culture based. The inherited reality in Otaniemi campus follows Allen's (ibid.) principle of field configurations, which unify diverse elements (the principle of following the contour lines of the landscape) while respecting the identity of each other (university, services and housing separated from each other), but simultaneously remain abstract. Emphasised field conditions in Otaniemi, such as the areas

from south, west and north from Alvar Aalto's campus, are following the principles of his original plan in an even more field condition type manner, based on solitary buildings standing on loose grids in forest. Compared to this kind of Finnish adaptation of Garden City thinking, the aim of an economically and culturally sustainable campus development rather has an emphasis on diversity, usability and pedestrians, where the users and uses mix and meet, and emergent changes are allowed instead of large fixed systems and structures (Cooper et al. 2009). The new campus development of Aalto University is aimed to produce urban, street-level meeting places for open innovation and social encounters (Aalto University 2015b). Accordingly, new internal renting model has diminished surplus areas of academic units and the freed spaces are treated as shared resources for work, housing and services, increasing the diversity and possibilities for interdisciplinary activities.

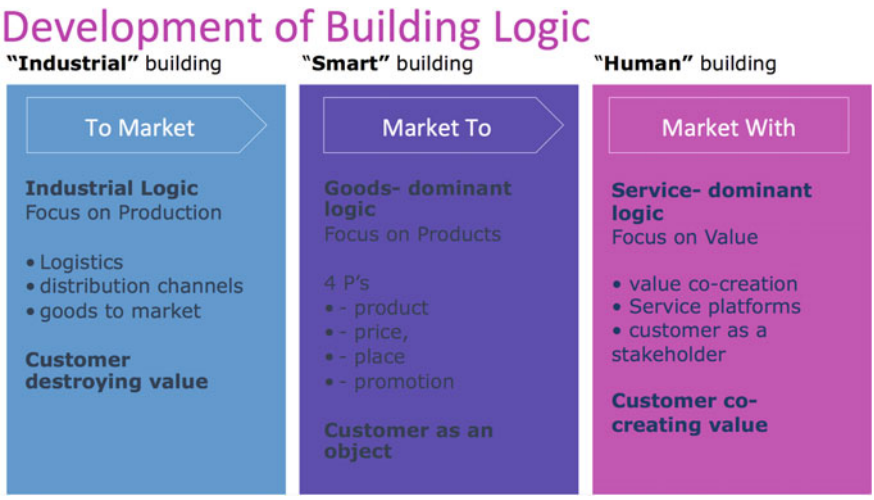
5 Building as a Service

One method of decreasing economic vulnerability at Aalto University is the *Building as a Service* or BaaS principle. This means a shift from a product-based logic to instrumental value in real estate development and architecture. This principle changes business models in the development processes of building and real estate. Here a customer becomes a partner in the creation of value for its operations. BaaS could be described as a disruptive innovation due to the potential of the paradigm shift to allow creation of simpler and more cost-efficient, user-oriented spaces.

Disruptive innovations have shaped the real estate industry and its growth in the form of technical advances and for example innovations in land use, the Harvard Real Estate Conference on Disruptive Innovation in Real Estate panelists concluded in 2014 (Harvard GSD 2014). Instead of disruptive technology, which is based on "product innovation", the BaaS principle, however, introduces a new way of thinking, a new logic, which would allow developers to create better service platforms and enhance customer experience by significantly altering the way buildings and spaces are designed, sold and used. This service-based innovation also enables new markets for customer oriented service operators (e.g. co working operators like We Work or accommodation operator AirBnB).

The shift from product based to service dominant logic can change business models, turning the conceptual focus of activities on instrumental value instead of intrinsic value. The customer thus ceases to be a target of action, and instead becomes a co-creator of value. In this logic, a solution is no longer based on the absolute properties of a product itself, but on the product's ability to serve the customer, and the product itself becomes mainly a mechanism to provide service, a service platform. The value of the product is determined by the beneficiary in this model: value becomes idiosyncratic, experiential, contextual and meaning-laden.

Table 1 The types of logic in relation to markets (Jarmo Suominen, modified from Lusch and Vargo 2007)



Service Architecture (a new professorship at Department of Architecture in Aalto University) describes the conditions of value co-creation and makes it possible to increase customer value instead of just adding product value. Environments, buildings and spaces could be evaluated as value conditions for value co-creation. Basic evaluation criteria is then the questions, do the conditions increase or destroy the value created by activities within?

As part of its strategy pertaining to the university premises, Aalto University will offer service-oriented solutions and spaces in Otaniemi. Increasingly, Aalto University buildings will no longer be just spaces, but also an ecosystem of resources managed and enabled by new service operations (Tables 1, 2).

6 Urban Integration

Campus sustainability programme (Aalto University 2016) combines the university with external partners, such as industry, government, and organised civil society. The mono-functional green-field campus gives space to a diversified city with mixed-use urban development. Partnering is the paradigm, with sharing economical risk, humanitarian programs, sustainability networks, city partnerships, greening events, schoolchildren interaction and cross-disciplinary programs. Companies are welcome to locate their personnel to the thematic quarters of the campus, supporting co-creation.

To enable the shift for decentralized to distributed, integrated network typology, Aalto University will promote multi-disciplinary collaboration and innovation according to its strategy, Aalto University is planning for new spaces with open entrance floors with "Open Innovation spaces", "Hubs" and "Working Cafés" suitable especially for meeting, mobile work and group work. Academic and artistic work that requires more dedicated and private space, is to be located in higher levels or the building, to ease moving around in the buildings as well as not to disturb the atmosphere of an open innovation environment (Aalto University 2014).

The trend of open, flexible meeting and working spaces catering to different levels of mobility in both staff and student use is visible throughout the University development and renovation projects. Väre, the new building for the School of Arts, Design and Architecture, set to be completed in 2018, will include large areas of flexible, round-the-clock meeting and exhibition spaces and working cafes in the lower levels, and dedicated material workshops and studio spaces reserved on the upper levels.

Dipoli, a former Student Union centre and congress centre, was recently purchased by Aalto University Properties Ltd and is being renovated into the new main building of the University, set to house the Aalto management, services and a wide selection of open meeting spaces to promote multidisciplinary interaction and to showcase Aalto University to stakeholders (Aalto University 2015a). The Aalto main library is renovated into a modern learning centre with a comprehensive array of services targeted toward staff, researchers and students alike. The bottom floor of the Learning Centre is also to be used as a meeting place and café, and the centre will emphasize group and individual meeting and working spaces and services that promote learning and research, such as instruction in study skills or research methodology, over traditional library services such as an extensive printed book collection.

7 Building as a Service: Learning Spaces and Student Involvement in Campus Development

A thorough understanding of the needs and wishes of users for spatial development as well as their collaboration in the development actions, ensures the quality, versatility and adaptability of new spaces, and increases the engagement of participants (Bovill et al. 2011). Involving people in development processes from an early stage also makes them less unwilling to implement changes (Rytkönen et al. 2015). In Aalto University, faculty, staff and students as well as key stakeholders from the outside the university are included in campus development processes through workshops, student projects, studies and co-creation.

An increasing amount of teaching and research resources are allocated for campus development activities (Ahlava 2015). Courses, assignments and theses are focusing around different aspects of campus development to investigate a multitude

of prospects and possibly provide ideas and plans for development. Student competitions have yielded already completed sustainable projects that enliven the campus area, such as the Decaying Garden where tree stumps are left at their growing sites to foster specific ecosystems, and the Otaniemi Urban Garden where faculty and students can rent gardening plots to grow their own food on campus.

Characteristic to Finnish universities and especially Aalto University, the student body, most importantly through the Aalto University Student Union AYY, is a proactive player in campus development. AYY owns most of the current housing in Otaniemi, and is developing more student housing near and on campus (Wallin and Staffans 2015). AYY is collaborating with Aalto student associations KY and TF in an effort to build a student centre in the heart of the campus area, near the key Aalto University development sites such as the Undergraduate Centre, the new Väre building and the Learning Centre.

By including students in development processes of learning spaces, the key principles of BaaS become realised even before the project itself has been completed: the co-creation of value and the user and service orientation of space is included in the design processes. The goals of the students to learn, of the University to teach and of the institution as a whole to create new knowledge and innovations are fulfilled even during the process to ensure that the spaces being designed serve those purposes. The commitment of the stakeholders to continue active development of their environment becomes ensured through co-creation. By involving students in development, the university also teaches key workplace skills such as communication, teamwork and organisational development, which support the abilities of graduates to have social impact.

This participatory process could be called as post-production of customer/user value where university will develop solutions (define solutions space), methodologies (robust development) and opportunities (choice architecture) to its stakeholders.

8 The University Campus as a Test Laboratory for Urban Development

In order to support the faculty, the goal of the campus development of Aalto University is to create and transfer knowledge that has societal impact and long time span, but also adaptable and open to change in order to enhance interdisciplinary collaboration. For students, which have a shorter cycle span, the campus is adaptable to change. The goal of the university is to create societal impact also in the actual campus development. Some of these developments are light, fast and inexpensive, following the model of *tactical urbanism*.

Tactical urbanism refers to short-term, community-based projects—bottom-up initiatives created by the users of a space with the intention of enlivening public spaces and influencing decision makers and developers in the area to see new potential and implement permanent improvements to the area in question. (Lydon

and Garcia 2015). In Aalto University, prime examples of student-led bottom-up projects that have become institutionalised are the Learning Hubs, and Startup Sauna. The first Learning Hub in Aalto was created as a pilot project by the students of international design business management, and functioned as a test site for the year 2011. Based on the experiences, user feed back and popularity of the first hub, over 15 have since been established in Aalto University, and are now in heavy use (Aalto Learning Centre 2015). They also serve as prototypes for the design of the Learning Centre. Startup Sauna, a start-up accelerator for new companies, was founded by Aalto Entrepreneurship Society following their successful summer start-up mentoring program, and has since mentored 173 start-up companies as of November 2015 (Startup Sauna 2015). Other examples of tactical manoeuvres at Aalto City are seasonal festivals, the forthcoming multi-functional Aino Square and temporary, community-built outdoor furniture.

9 School as a Service: A High School Integrated to Local Learning Communities and Former University Facilities

The role of the school has changed fundamentally. From the temples of teaching they will change to labs for learning. Focus is on conditions that are best supporting new learning methodologies and will increase the value of activities.

One example of BaaS thinking in practice in Otaniemi is the School as a Service project. The university is developing, together with the local municipal school authority, a new type of school, a Co-School. School as a Service is being developed with the City of Espoo and it will open to students in autumn 2016. The concept has also been developed further in collaboration with Royal College of Art, London and Tongji University School of Design and Innovation, Shanghai, during 2015–2016.

The Co-School is based on shared spaces and integrated communities of practice (Lave and Wenger 1991) between the university and the school, the practice of flipped classroom elevated to the level of flipped school (emphasising discussion instead of reading at school) and campus thinking instead of hermetic school buildings. The school becomes a service, not only a physical place. Various locations at the premises of the university are shared. There is an underlying paradigmatic change of the processes of planning and design interaction with physical design. Spaces and their uses become creatively decoupled. Flexibility and sharing maximises use ratio, but also social encounters. The co-school pursues a service dominant logic, bringing new contents to learning, transforming school towards a platform for social learning, developing new spatial practices supporting motivated learning, pursuing learning everywhere and the joy of learning.

In practice, School as a Service concept will include elements of "something old, something new, something borrowed and something blue" (see Table 3). More precisely these elements are following, something old: the Co-School will have its own home base in an existing building. The building will be renovated to contain basic learning spaces and administration. Something new: there is a proposal to create a new student lounge as an identity-injecting element to the new high school. Something borrowed: shared resources in Aalto campus enable both the utilization of vacant spaces and the integration to the existing communities of learning (e.g. Design Factory and Startup Sauna). Something blue: the ecosystem of on-demand resources are branded and developed for open purposes of shared use for all stakeholders on Aalto City (Table 3).

There are various physical, social and virtual resources and systems in within a ten minutes' walk. Figure 2 shows the most immediate resources for the Co-School project. The school is defined both by its own immediate base and by its close neighbourhood and accessible resources as an ecosystem of learning. Campus is seen as a service platform as a consequence (Fig. 3).

Table 2 A comparison of two concepts: the conventional principle of school as a product and the innovative school as a service (Jarmo Suominen, Aalto University)

School as a product	School as a service
Operand resources	Operant resources
Tangible	Intangible
Value added	Co-creation of value
Goods	Service
Products	Experiences
Transactional	Relational
Units of output	Processes
Promotion	Conversation/Dialog
Brand quality	Customer equity
Profit maximization	Financial feedback

Table 3 The characteristics of the school as a service model in Otaniemi (Jarmo Suominen, Aalto University)

Something new	Something old	Something borrowed	Something blue
			
• New Structure • Identity building, lounge and meeting point • Private, dedicated school use	• Existing Structure • For learning and shared use • Semi private	• Shared accessible platforms • Semipublic	• Open, shared resources • Public

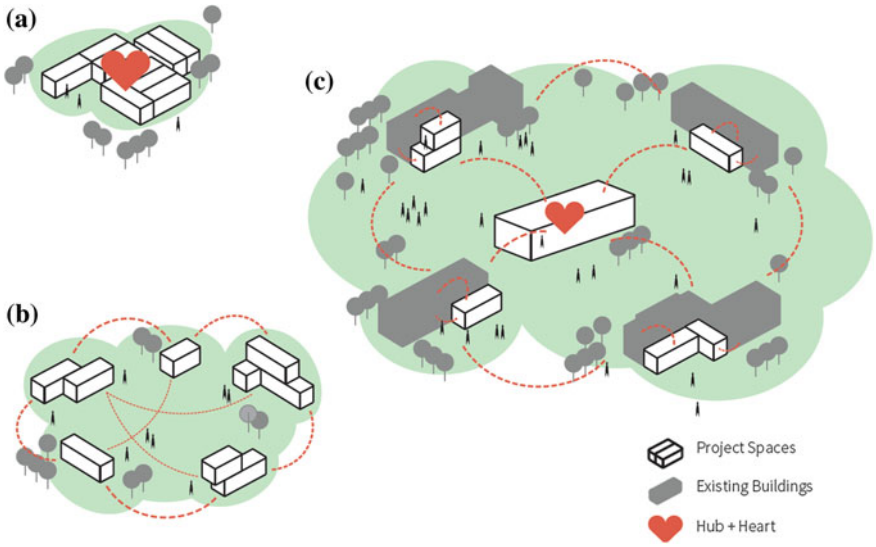


Fig. 2 **a** The Co-School in Otaniemi has a heart, a base building, where the pupils gather every morning. **b** The learning spaces, shared with the university, are spread throughout the Aalto campus. **c** The Co-School might also have new additions to existing buildings (Shiyang Shao and Huan Wang, Aalto University)

Fig. 3 The map of the facilities of Co-School in Otaniemi (Joshua Page, Aalto University)

10 Conclusions

Universities are currently facing a changing environment: working methods are evolving globally, and work has become less tied to a specific location or time, and more collaborative (Rytkönen et al. 2015). At the same time, universities experience financial distress due to increasing cost of education per student, increasing demand for higher education, and a period of slow economical growth that has decreased state funding for universities in many countries (Altbach et al. 2009). This paper has described the methods of Aalto University in Finland to tackle these challenges. Generisable solutions from its campus development related to risk

management, have been (a) creating a diversity of scientifically and culturally thematic cross-disciplinary areas and shared spaces on campus, mixing the people of the university with other institutions and companies, (b) local energy production, changes in consumer behaviour and a clever use of the energy network and (c) utilising the principle of Building as a Service. The first solution can be useful in regenerating cultural vitality in the case of removals, the second in environmental challenges and the third in economic challenges also elsewhere.

Facilities make up a large portion of costs for universities, and their utilisation rates are declining heavily due to a more mobile working culture. For example in Aalto University, utilisation rates for spaces are between 20 and 40 % during office hours, and there is great pressure to increase the rate of use and reduce the amount of total spaces by condensing the campus to a more compact and functional system (Rytkönen et al. 2015).

In adapting to these changes, the proposed and tested ideas of Building as a Service, co-creation of new spaces and institutional support for bottom-up community initiatives to enliven campus areas could be implemented and used to create a more user-based, flexible and sustainable campus for tomorrow. This will potentially also lead to the development of the more agile use of university spaces as a service. As a consequence of this logic, the whole campus as a part of a city could be defined as a service, and more precisely, as a service platform enabling new markets for service operators and better conditions for value co-creation.

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Author Biographies

Professor Antti Ahlava is a practicing architect, specializing both in building design and urban design. He teaches design methods in architecture and is responsible for the campus development of Aalto University. He received his doctorate in design from the University of Art and Design in Helsinki in 2002, where he researched architecture in consumer society. He first taught at the University of Technology in Helsinki and was later a Visiting Professor at the Royal Academy of Art in Copenhagen and Aarhus School of Architecture. He became Full Professor in Emergent Design Methodologies in Aalto University in 2014 and has been the leader of its interdisciplinary Group X (groupxaalto.fi) since that. He has also taught at Yale, UCLA and RCA and was recently a Visiting Fellow at Harvard GSD. Ahlava's architecture practice helsinkizürich has been commissioned by cities and private companies in the design of city centres, public building, residences and recreational facilities. He has won prizes in international architectural competitions in Switzerland, Germany, Qatar, China and Finland. He would like to thank everyone who has been involved with the campus development of Aalto University during the past two years and especially professor Jarmo Suominen, whose developments in service architecture have been crucial also for this article.

Adjunct Professor Jarmo Suominen Mr. Suominen studied architecture at Tampere University of Technology, where he received his Master's degree in 1990. He has worked as Director of Future Home Institute and Professor of Mass Customization at Department of Design in University of Art And Design, later Aalto University, 2002–2012. He has had many positions at Massachusetts Institute of Technology, Media Lab, and Department of Architecture since 1999 (Visiting Scholar, Visiting Scientist and Senior Advisor), related to customization strategies and methodologies. He is currently a team member in Changing Places Group MIT Media Lab. He has been visiting professor in College of Design and Innovation at Tongji University since 2015. Jarmo has led over 20 considerable research projects related to his specialist fields: Kalasatama, Work + Life, Energizing Urban Ecosystems etc. He has also arranged the Customization and Personalization World Congress in 2009 and has been in MIT Smart Customization Group since.

Graduate student Saana Rossi is a Research Assistant for Group X of the Department of Architecture at Aalto University (groupxaalto.fi).

Sustainability Education: Towards Total Sustainability Management Teaching

S. Boron, K.R. Murray and G.B. Thomson

Abstract

The triple bottom line [TBL] "definition" of sustainable development [SD] is basically flawed. This prevailing school of thought adopted wholesale by much of business, industry and government is not making much headway in the quest for a sustainable future (Our Common Future 1987) [OCF]. What's more, many higher educational establishments are themselves followers of this current thinking, embellishing and serving it rather than challenging or redressing it and thus exacerbating the problem further (Jones et al., Sustainability education: Perspectives and practice across Higher Education, 2010). A rethink and a re-focussing of the true meaning and nature of SD and of the resulting consequences for practical environmental and sustainability management, is long overdue. As early as 2001 the authors introduced, at Masters and post graduate level a teaching program that clearly defines a structure and methodology for Total Sustainability Management [TSM] for business, enabling the generation of strategies for the attainment of sustainable processing. This paper summarises the failures of the TBL approach to SD, and also the development, procedure and

S. Boron (✉)
Department of Chemical and Process Engineering, Heriot Watt University, Riccarton Campus, Edinburgh EH14 4AS, UK
e-mail: s.boron@hw.ac.uk

K.R. Murray
UHI-Lews Castle College, Stornoway, Isle of Lewis HS2 0XR, UK
e-mail: krm_tsm@yahoo.co.uk

G.B. Thomson
Heriot Watt University, Riccarton Campus, Edinburgh EH14 4AS, UK
e-mail: g.b.thomson@hw.ac.uk

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implementation schema of the teaching program and its outcomes over the last 15 years with particular reference to the EU Masters program at the Ecole des Mines, Nantes in France.

Keywords
Education · Sustainability management · Triple bottom line

1 Introduction: Background

The ultimate purpose of academic teaching programs orientated around "sustainability" is to support the practical attainment of a sustainable future for industry, business and society. The prevailing schools of thought and current practices in environmental and sustainability management within business and industry based on the triple bottom line [TBL] approach to SD are however finding it difficult to make much headway in this quest (Hall et al. 2010). There is also much evidence to suggest that the serious challenge posed by the "Brundtland" report over 25 years ago (Our Common Future 1987) [OCF], to make SD happen by the turn of the century has born little fruit despite the best efforts of many individuals and organisations.

The reasons are various and include:

- Disorientation and a loss of focus on sustainability fundamentals;
- Confusion of the TBL with SD;
- A striving for more sustainability without reference to an ultimate absolute goal; and
- Managing problems arising out of the un-sustainability of development rather than managing ourselves and the way we do things.

The TBL approach is characterised by envisaging that SD is somehow embodied in the three "domains of sustainability", the social, the environmental and the economic, when by refocussing on the original OCF definition, this is clearly not the case because SD is actually a form of development path that has continuance and is process orientated.

Many higher educational establishments unfortunately tend to be followers of this current TBL thinking and practice, embellishing and serving it rather than challenging or redressing it (Dale and Newman 2005; Jones et al. 2010).

The overall long term viability of business and industry depends not only on its profitability which is a function of prevailing economic drivers but also on its sustainability which is defined according to its interaction with the surroundings. Profitability rules however need to engender sustainable action, otherwise trade off will always figure in the management "solution", as is the current norm. It is only

natural that business practice is dominated by profitability issues, but if sustainability programs are not properly linked to and integrated with profitability then they will be ignored or even dismissed as a result. This is the essence of what we have called the Business Dilemma (Boron and Murray 2004).

Sustainability in fact is simply the ability to continue while Development defined in the "Brundtland" sense is made up of procedures and processes operated for the meeting of needs so that SD is the meeting of needs in a way that has continuance (Porritt 2005). When SD is adopted as the desired goal it has to be planned for and systematically and deliberately implemented, for it cannot be achieved as a bolt-on to a system that is essentially un-sustainable as our present industrial system is (Clift 1998; Boron and Murray 2004). This means that all activities undertaken for need satisfaction have to be consciously designed to have continuance if the Development is to be made Sustainable. Any toolkit used for management purposes will then need to explicitly embody SD principles to be properly effective and must take account of the Business Dilemma which is a significant barrier to achieving SD in practice. In the case of Total Sustainability Management (TSM), sustainable processes are designed and delivered within a proactive and dedicated management system using the ISO 14001 (2004) framework as the vehicle (Boron and Murray 2003).

With regard to teaching, the challenge must be to expand the educational coverage of the subject to include all the features and paradigms that are discussed here, properly focussed and in touch with sustainability and SD fundamentals. Just as sustainability has to be sought for deliberately and designed into systems of production and consumption so ultimately it has to be properly integrated into the educational programmes that support it in an unambiguous and dedicated way.

For those technically minded, the deliberate nurturing of sustainability in all walks of life, is like management by feed-forward control where total sustainability, the desired outcome, is designed into the operation. Current management practice unfortunately is reactive or feedback in nature and depends on things going wrong first before corrective action is taken. With our industrial production systems locked into an unsustainable development path, things have indeed gone badly wrong (Boron and Murray 2004).

2 Refocussing on SD

Many publications on sustainability and SD include the "traditional" definition given at the outset of chapter 2 OCF, "*Sustainable Development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.*" but that's as far as it goes (Waas et al. 2011). No real attempt is made to identify the wider ramifications of the definition which would clarify and establish a practical procedure for its implementation. Usually this original definition is only given lip service and the way is then open to misinterpretation and embellishment and often what follows is a switching into some

other preconceived notion of sustainability or SD. Unfortunately OCF also muddies the waters by including ambiguous and unclear discussions scattered throughout the body of the report that detract from the original definition diluting and distorting its meaning.

OCF however does reveal the following:

- SD is not merely an idea, but a principle, dependent on resource availability.
- Its central theme is the equitable access to all manner of resources required for satisfying human needs, which aught to be viewed according to the "Maslow hierarchy" (Koltko-Rivera 2006); and includes inter and intra generational equity as well as inter-economic equity as vital elements.
- SD is a property of the methods and ways we achieve need satisfaction and is therefore process orientated.
- SD contributes a "sustainable cash stream" to GNP and is fundamental to green growth.
- The sustainability or continuance of development is not the same as the continuance of the environment or of society or of the economy, all of which are an outcome of SD not its main feature. Similarly environmental problems and poverty are symptoms of un-sustainable development which means that poverty is not a root problem but an outcome.

Returning to the bullet points given in the introduction;

The advent of the TBL and its subsequent practical implications are the most serious disservice to environmental and sustainability management, shepherding activity into an unproductive and largely ineffective cul du sac (Milne and Gray 2013).

- The idea that meaningful sustainability action is somehow primarily concentrated in the three domains of environment, society and the economy has little to do with the real essence of SD which is primarily concerned with the way we go about our business.
- The TBL philosophy has therefore successfully deflected attention away from the central issue of managing ourselves and into managing symptoms that appear in the three TBL domains.
- Current management activity is problem orientated with the sustainability (continuance) of all sorts of things within the TBL domains taking centre stage rather than the sustainability of what we do, which after all is the root cause of all these problems.
- A journey needs a direction and a destination (a goal) otherwise relativism sets in. A goalless more/less culture leads to a journey of dubious effectiveness. Like the goal of "zero defects" being important for TQM (Crosby 1979) so "zero resource availability infringement" [RAI] is the indispensable goal of TSM (Boron and Murray 2004).
- The original purpose of economic activity has been wealth creation. In the present economic climate any environmental episode or condition (smog, acid

rain, NO_x, global warming) is unfortunately considered a nuisance that can be resolved by legislation or treaties so that business as usual can continue. This historical legacy has instilled a one problem one solution mentality.

- Problems however are only symptoms of a much more fundamental malady that remains largely unaddressed. We are the problem and just as with TQM (Crosby 1979), TSM is also a procedure centred on the way *we* do things.

Over 10 years ago all these ideas were used to formulate the basis of the TSM framework and procedure that will yield strategies for the achievement of sustainable processing routes (Boron and Murray 2003), that are the foundation of sustainable business, that in turn support a sustainable economy. TSM with its required supporting paradigm frame then became the kernel of a teaching programme and dedicated module that was designed for the further education of Engineers and that was implemented in the masters curricula of both Heriot-Watt University in Edinburgh and later in the Ecole des Mines Nantes in France.

3 Teaching Programme Overview

At the Heriot-Watt University, TSM was introduced into the Chemical Engineering curriculum from the late 90s and later consolidated into the final year's design project (Pekdemir et al. 2006). Since 2005, a consolidation of TSM has continued in both the B. Eng. & M. Eng. undergraduate programs and the postgraduate, Sustainability Engineering Masters (delivery, Thomson & Boron).

At the Ecole des Mines, Nantes, a European Joint Masters in Management and Engineering of Environment and Energy has been running for over 15 years (delivery, Boron & Murray). The program provides the knowledge and skills to create tomorrow's leaders in environmental management, renewable energy, and sustainability. The current annual uptake by post graduates is +40 from over 15 international countries.

As early as 2001 staff from the Chemical and Process Engineering Department, Heriot Watt University, UK have contributed a taught module to this program. Over the years changes have been made to take account of the developments in industrial thinking regarding such issues as Corporate Social Responsibility, SD and the way in which stakeholder pressures and Environmental protection affected business operation.

The module at its core, introduces a TSM structure into the now well established ISO 14001 (2004) framework. The students are prepared for staff student contact time through recommended reading material and hand outs before the course starts. They are challenged at the outset with new or forgotten paradigms and invited to refocus their thinking. It is especially useful for them to come to the course with a "clean sheet" so that all their prior knowledge and experience in the subject area is put on hold (Milne and Gray 2013).

Over a period of 3 days the students are shown how to introduce sustainability criteria into the structure of an existing management system, ISO 14001. They start by considering a stakeholder pressure experience that has affected a specific company and they report back to the class on what action they might take in that situation. This is used as a benchmark.

An existing company EMS that they have been given to evaluate is adapted to reflect TSM thinking. In line with TSM principles and procedures (Boron and Murray 2004), the students are then guided to modify their initial thinking and to implement appropriate changes to their company operation.

The class numbers initially were ~25–30 students up until 2007, but that rose to +40 between 2008 and 2010 and has continued at that level over the last 5 years. At the same time the age profile, discipline, nationality and social mix has changed considerably within that timeframe. With this size of the class, it is important to maintain proper staff/student ratios for effective knowledge/experience transfer. It's the personal contact that makes the difference.

The final outcome of the exercise is to present key short, medium and long term strategic plans for their case study company in their quest to achieve total sustainability.

Because economic profitability rules are often a hindrance to SD the students draw up two strategy scenarios, one with and the other without economic constraints allowing a "sky's the limit" benchmark to be established.

Armed with this in house experience the students are then challenged to tackle a similar exercise as part of their individual and group assessment. Students of different nationalities and disciplines are placed in groups of 5–7 and "act" as the Board of a company which is charged with installing sustainability management into that company's operations.

4 Background Scenarios for Sustainability Assignments

Each year the student groups are given a, "Background Introduction" to an industrial scenario that they would be facing, often based on ideas inspired by various EU initiatives. This scenario provides the context within which a sustainability strategy for their individual organisation is to be developed.

Before 2012, the assignment focus was on individual companies in their quest for total sustainability. However, in 2012 the background theme used, was the development of a sustainable production and consumption strategy for the future, based on the EU Sustainable Development Strategy (EU SDS)[1]. The "companies" were asked to, develop and implement a pilot level regional sustainable production and consumption strategy for a range of locally grown and processed agricultural products.

[1] http://ec.europa.eu/environment/eussd/ (April 2015).

In 2013 the background theme was based on the Manifesto for a Resource-Efficient Europe[2]; to support the shift towards sustainable growth via a resource-efficient, low-carbon economy.

In 2014 having seen the success of the previous year's graduates, the challenge was to imagine that a grant of €350,000 had been given to the local Chamber of Commerce, to foster and encourage an initiative to go "Beyond ISO 14001" with regard to "Strategic Planning for total sustainability" The students again used the TSM approach as the basis for their own companies "sustainability" and then explored the best way to allocate the grant money across the groups.

Last year (2015) the focus was on the implementation of TSM within Global Multi-National Companies. Here the parent company had charged the seven subsidiary national sites to review their specific operations with a view to developing a short, medium and long term sustainability strategy. They were also asked to submit a joint recommendation to the Group Chairman on how they felt the Group should project its corporate "sustainability" image.

Over these last two years, although the application of TSM methodology is always at the core of the assignment issue, working together with other enterprises has fostered an element of "communal" industrial symbiosis, central to practical sustainability and SD. The project scenarios that were developed provided the groups with ample opportunity for cooperation initiatives and other schemes, testing their out-of-the-box thinking abilities in applying TSM and its outcomes in innovative ways.

5 Module Outline: Introduction

Sustainability is a binding constraint imposed on business whose effect is becoming more tangible every day. According to the original intention, the word sustainable is an adjective meaning continuance.

> Anything that can go on being done on an indefinite basis is sustainable. Anything that cannot go on being done indefinitely is unsustainable. (Porritt 2005)

The sustainability or continuance of a company or business is essentially tied to the way the company operates. The company's activities and operations have a crucial bearing on its sustainability and its long term survival.[3] For various reasons much of what a company does currently, has negative side effects undermining its survival (Fig. 1).

[2] http://ec.europa.eu/environment/resource_efficiency/about/roadmap/index_en.htm (April 2015).

[3] www.un-documents.net/our-common-future.pdf (September 2015).

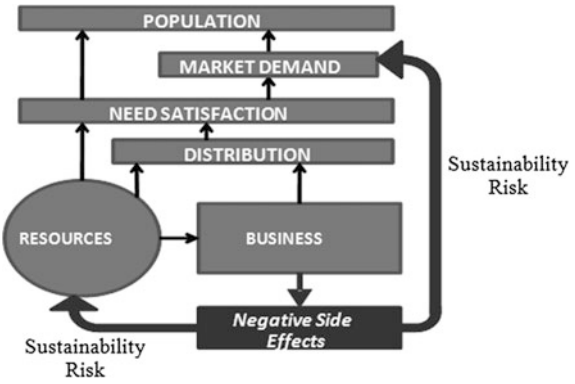

Fig. 1 The "needs satisfaction" inter-relationship between business, resources and the market

Identifying and rectifying such activities in a systematic way allows the organisation to introduce a planning system that encourages business continuance.

Three primary questions need to be answered by the company:

1. *What is it that undermines our ability to survive, and which of our activities across the entire cradle to grave extent of our operations are un-sustainable?*
2. *What are the risks to our business from these un-sustainabilities?*
3. *How can the negative effects of these activities be diminished and eliminated altogether.*

The business is more than just the factory. It must include all supply chains and all use phase areas served by the goods and services produced. Similarly the resources that underpin the company activity are much more than just raw material and services.

The company relies on the availability of a skilled work force, various human institutions and the natural environment. The company needs a distribution system and a marketplace for its goods and services and a way of assimilating its wastes (Table 1).

The company is at risk if any of these resources or requirements comes under threat. Un-sustainable negative side effects of company operation can be mitigated by reacting to problems caused as they arise, or, they can be deliberately targeted en mass by developing a coherent proactive strategy that aims to eliminate them completely. At this stage any un-sustainability inherent in the company is discovered and noted. Using this approach, the long term viability of the company will also become apparent for no matter how you try some operations are inherently unsustainable and should be removed.

Table 1 The table lists and identifies resources arising out of the definition of need satisfaction

Business (sustainability)	Resources		Human (sustainability)
1: Natural resource availability (F)	Raw materials; services (air, water, energy) Life support, assimilative capacity, bio productivity and diversity, environment integrity, climate stability		1: Natural resource availability
2: Human resource availability (F)	Workforce (intelligence, health mobility, work capacity resourcefulness). Inter and Intra generational equity; inter-economic equity. equitable, social justice		2: Human resource availability
3: Manufactured resource availability (D)	Capital equipment; infrastructure networks, the built environment; transportation; distribution networks		3: Manufactured resource availability
4: Social resource availability (D)	Human institutions, organisations (education policing banking etc. Economics Justice courts etc.)		4: Social resource availability
5: Market opportunity availability (F) (E)	Maslows hierarchy of innate needs shows subsistence level needs (F) all the way through to specialised needs or wants that are extra (E)		5: General need satisfaction
Secondary condition	Economic	Secondary condition	
6: Profitability (D)	Framework of rules for value allocation	Cash	Livelihood
7: Financial capital (D)	Device for resource value allocation and measurement		Access to finances; pay; purchasing empowerment

F fundamental, *D* desirable, *E* extra

6 TSM Implementation

Starting from a classical process flow diagram (Fig. 2) showing the activities of an organisation within the factory, the students are asked to extend their responsibility beyond their factory fence (Fig. 3). The criterion that determines the sustainability of an operation, the undermining of the resource base, is then applied across the organisation's operations from cradle to grave using a refined Sustainability Risk Profile Procedure (Boron and Murray 2005; Selmes et al. 1997). An operation is sustainable if it does not undermine an element of the supporting resource base; examples are given in Table 1.

The outcome of this management procedure identifies the un-sustainable aspects and activities within the entire cradle to grave extent of business operations. Two lists prioritising remedial action to remove these un-sustainabilities are then created:

1. Measures to achieve total sustainability unrestrained by economic conditions.
2. Short term and medium term strategies identifying measures for total sustainability achievable within the prevailing economic system.

Usually remedial action starts within the factory fence and in areas of the operation over which the business exerts direct control. Technological and policy options are identified that can be applied here. In TSM however two other areas that lie outside the factory fence are also considered. Those over which the business has (1) limited control or (2) no direct control at all. Company sustainability is indirectly affected by these external operations and their negative interactions with the

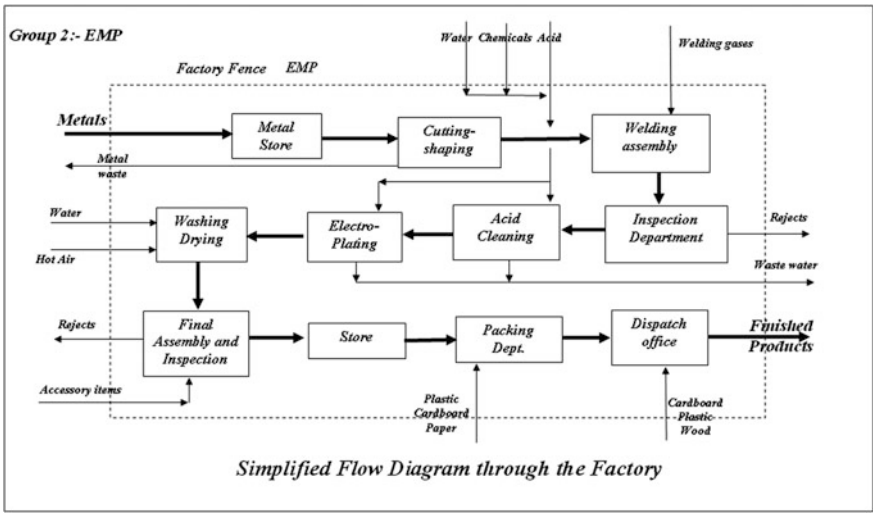

Fig. 2 Simplified flow diagram, electro-metal plating (*case study, 2*)

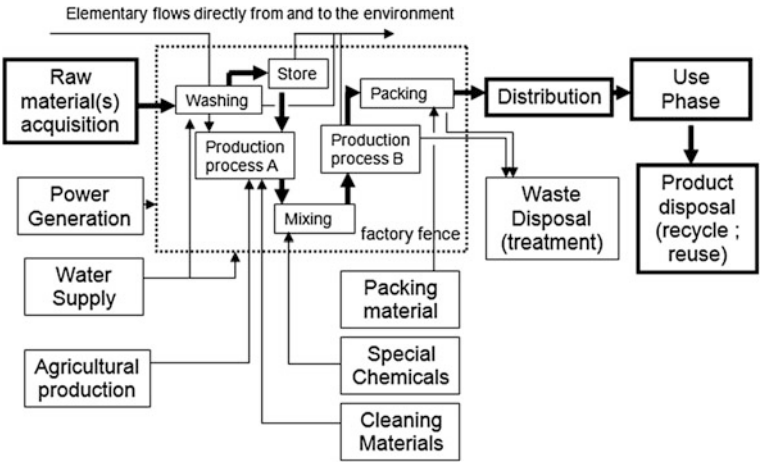

Fig. 3 Cradle to Grave view beyond "the factory"

surroundings and resource base have to be accounted for and ultimately eliminated for they represent a risk to company viability that is imported into the factory.

The groups of students acting as the Boards of their companies are now asked to consider these sustainability "aspects" lying outside the factory fence over which they may have some influence (Fig. 3) and to propose strategies for their reduction and removal. Finally, even the external interaction over which the company exerts no influence at all need also to be addressed and ultimately dealt with.

Over the three day course, having produce a sustainability policy and strategic plan according to the target of total sustainability for their company the outcomes often highlight some key issues and activities over which they have little or no direct control, in particular infrastructure services.

In some cases the frightening realisation is that their company will never be sustainable and as such the "company Boards" are encouraged to consider plans that should be put into place to diversify, change direction to survive or even plan to shut down operations altogether!

Armed with this background training, the groups then tackle their allocated assignment within the context of the "concept" theme presented to that particular year group (see Background scenarios). They submit both a group report and oral presentation, each student being responsible for their agreed area of the project. Over and above the "knowledge and understanding" presented in the group reports, the final oral presentations allow the students to also go well beyond this in their exploration and awareness of the problems facing the particular industry that they have been working with. This gives them valuable insight were they to take up graduate employment in that market sector. Ideally during the whole course all the groups should be learning from each other.

7 Discussion

As mentioned earlier, this course has gone through radical changes over the last decade in format and structure as the authors annually reviewed the student's presentations and reflected on what should be the best way to adequately and succinctly transfer the required knowledge and understanding.

With the graduate discipline mix largely dominated by engineering, one of the single biggest problems we have had to tackle has been to encourage the groups to look beyond their own company boundaries. Engineers immediately focus in on the "safe" in-house techno-solutions to problems offered by their disciplines and expertise and seek to apply these to their organisation. This approach is really limited, aiming only to resolve current environmental, energy, water, re-cycle or zero waste issues as they arise.

Even though in the last 3 years we have deliberately created the opportunity both directly and indirectly in the class case studies and the group assignments to go beyond their discipline, these students have great difficulty in considering issues and opportunities for collaboration and co-operation out with their sphere of expertise and influence.

In the last 2 years however any difficulties have been further exacerbated with mature post graduates joining the program from industry. Having been subjected to the rigors of their company's practices, culture and ethos, particularly in relation to the TBL approach to SD they not only have difficulty in leaving these "experiences" outside the lecture theatre but will apply them instead of the TSM methodology to the group assignments. They also have a tendency to take over as leaders of their group because they "know" what they are doing thus dominating younger or less confident post graduate colleagues.

This problem made itself manifest in 2015. A group, influenced by industrial backgrounds, submitted their assignment without implementing the TSM methodology with its inherent objectives and targets and the attendant sustainability criterion of zero RAI. The situation was partly resolved through a re-submission but steps will be taken in 2016 to ensure that this is less likely to occur again.

This state of affairs can be traced back to the aforementioned prevailing disorientation confusion and lack of focus affecting all things "sustainable" that is rife in many industrial and academic circles. For at least the last decade the accepted practice for companies and academic teaching programs alike has been to define SD through the TBL "metaphor". As this has become the accepted norm, the authors are witnessing especially in some of the industrial candidates an inability to consider sustainability aspects and definitions as they really are and also to accept zero RAI (resource availability infringement) as a concept that should be the company's sustainability target (see Sect. 2).

This mirrors exactly the reluctance of many back in the 1980s to accept the concept of zero defects as an objective/target for TQM (Crosby 1989).

It could be depressing for TSM to discover almost 30 years later that a goal of zero defects is still considered an "unrealistic target" an un-economic objective to be ignored and rejected (Anvari et al. 2011). Yet in an economic system aiding and abetting un-sustainability it should come as no surprise that there is an inherent resistance to anything that challenges the status quo.

Notwithstanding this however, the authors have found the course to be a very succinct way of introducing the reality of SD into good effective business practice. The graduates freed to express themselves, are more than able to assimilate the course thinking and to apply this approach to their present or future company.

In the opinion of the authors, company delegates experiencing the course will at least be given a reality check on their company's sustainability standing and activities and their long term significance, and although at present they may wish not to release this into the public domain it will nevertheless form the basis of a sustainability strategy, a plan B if you will, to be enacted as opportunities arise.

8 Outcomes

On completion of the module any year group has in the main successfully demonstrated that it has developed the ability to:

- Assess the root causes of business un-sustainability over the entire cradle to grave extent of its operations. (9)
- Use environmental management systems ISO 14001 and the basic framework of Life cycle Assessment ISO 14040 for practical sustainability management. (6)
- Create "back-casting" strategies for the achievement of SD for an industrial process or business within a cradle-to-grave context with and without economic constraints. (9)
- Understand the limitations of current SD "activities" especially those centred about the TBL "proxy" and to assess the effect this has on the definition of the sustainability problem and its practical solution within business. (6)
- Discuss the issues involved in practical SD, work together with others on a common resolution and then to present the results both verbally and in a structured written report. (10)

The numbers in brackets score the success of each outcome item on a scale of 1–10.

9 Conclusions

This paper summarises the growing appreciation that the Triple Bottom Line is not a realistic approach to achieving Sustainable Development and as such should be challenged by higher educational establishments in its implementation. The design and operation of sustainable systems is at the heart of the application of the

principle of sustainable development, whose implementation is more urgent than ever 25 years after the "Brundtland" recommendations to the effect. Within the taught module, the extent of sustainability, a binding constraint of an Enterprise, can be easily assessed and strategic plans developed by the Engineering students to take the Enterprise into sustainable development as far as possible. The required paradigm shift away from TBL thinking and into TSM is proving a difficult challenge for many however, and really requires a TSM culture to be nurtured throughout earlier years of study.

> If, sustainable development continues to be used as a "smokescreen" to justify "business as usual", the realization of its original intent will be impossible. (Waas et al. 2011)

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Author Biographies

Stefan Boron graduated in Applied Physics in 1970 but was quickly "assimilated" into the Chemical Engineering fraternity through his Ph.D. in particle size measurement and, over 30 years of lecturing experience in the department of Chemical Engineering at Heriot-Watt University in Edinburgh. His teaching interests and subjects of expertise include Process Control and Thermodynamics and Particle technology. Early in the 1980s he became involved in Environmental Pollution Control and later in Sustainability, developing the key sustainable processing module for the masters program. Research into the applicability of Life Cycle Assessment and Environmental Management Systems to Sustainability Management resulted in the development of the Total Sustainability Management (TSM) concept and framework currently used in final year Chemical Engineering Design and in the development of Sustainable Processing. After his Retirement in 2006 he has concentrated on developing the field of TSM for application in Post Graduate and CPE training for Engineers in Universities in the UK and abroad.

Keith R. Murray spent over 9 years in the chemical equipment supply industry before joining the Heriot Watt University as a lecture where he spent the next 35 years teaching, researching and consulting in environmental, sustainability and other related subjects before retiring in 2005. For fun in 2009 through UHI, Lews Castle College, he graduated with a Research Masters from Aberdeen University; *EC glass and its contribution to the built environment*. In 1981 he became the founder Editor of Elsevier's Aquacultural Engineering (AE) and Chairman of the Chemical Engineering AE subject group. In 1993, with his colleague, Dr. Boron he initiated a post graduate M.Sc. program Environmental Pollution Control Management which by 2000 was re-named Sustainable Process Management. He continues to make a contribution to the Masters program at the Ecole des Mines, Nantes.

Gillian B. Thomson graduated with a first degree in Pure and Applied Chemistry in 1992 from Strathclyde University in Glasgow, and subsequently a Ph.D. in 1997. Joined Heriot-Watt as a Lecturer in Chemical Engineering in September 1997. She is a Member of the Royal Society of Chemistry and hold Chartered Chemist and Scientist designations. She is also an Associate Member of the Institution of Chemical Engineers; teaches at various undergraduate levels, including introductory process calculations, design & viability and research projects, the Sustainable Process Management M.Sc. course and Director for Academic Quality across the School, Admissions Tutor for Chemical Engineering.

Fostering the Professionalization of Business Students Through Education for Sustainable Development at University

Elena Escrig-Olmedo, M. Ángeles Fernández-Izquierdo, Idoya Ferrero-Ferrero, Raúl León-Soriano, M. Jesús Muñoz-Torres and Juana M. Rivera-Lirio

Abstract

Achieving sustainable development will not be possible without the effective integration of education for sustainable development (ESD) at all educational levels. However, to include these aspects in the university context, it is necessary to provide professors with mechanisms, resources and tools that allow the transmission of social and environmental concerns of our society to the students, obtaining as a result informed and responsible professionals in their fields of specialization. In this context, the objective of this paper is to present successful learning experiences which introduce the concept of sustainability in the area of business studies, and promote a more responsible professional development of the university business students. Moreover, these experiences could help

E. Escrig-Olmedo (✉) · M.Á. Fernández-Izquierdo · I. Ferrero-Ferrero
R. León-Soriano · M.J. Muñoz-Torres · J.M. Rivera-Lirio
Group SoGReS-MF (Sustainability of Organizations and Social Responsibility Management-Financial Markets), Department of Finance and Accounting, University Jaume I of Castellón (Spain), Campus del Riu Sec—Avda. Vicent Sos Baynat s/n, 12071 Castellón, Spain
e-mail: eescrig@uji.es; sogres@uji.es
URL: http://www.sogres.uji.es/

M.Á. Fernández-Izquierdo
e-mail: afernand@uji.es

I. Ferrero-Ferrero
e-mail: ferrero@uji.es

R. León-Soriano
e-mail: rleon@unizar.es

M.J. Muñoz-Torres
e-mail: munoz@uji.es

J.M. Rivera-Lirio
e-mail: jrivera@uji.es

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university educators in their ESD professional development. These innovative experiences have been applied in the Spanish University System. The findings of this research bring knowledge about the understanding of the sustainability concept in a high education context.

Keywords
Education for sustainable development (ESD) · Sustainability · Higher education

1 Introduction

United Nations saw the need for education on the concept of sustainability—at all levels and in formal and informal education—to raise awareness about social and environmental problems, according to the Decade of Education for Sustainable Development (UN 2002). According to UNESCO, education for sustainable development (ESD) is defined as "*an emerging but dynamic concept that encompasses a new vision of education that seeks to empower people of all ages to assume responsibility for creating a sustainable future*" (UNESCO 2002: 11).

Education, and specially Higher Education, has an important role in creating sustainable solutions to the current problems of the world for two basic reasons. On the one hand, the university student has the degree of maturity required to analyse complex concepts—as the broad term sustainable development. On the other hand, the social impact of a university education in sustainability can be greater than in other educational levels, either by the ability to put into practice the concepts learned in the short term or the potential influence they can exercise to hold positions of responsibility in organizations.

A key issue of the integration of Spanish universities into the new European Higher Education Area (EHEA) is to prepare students for their future careers as well as maximizing their personal development and their contribution to a sustainable and democratic knowledge-based society.

In this sense, it is necessary to introduce in the teaching programs a debate around issues of sustainability and social responsibility in organizations, in order to train and develop future professionals that strive to progress towards sustainable development. In this regard, business management field has become one of the most noticeable areas to accelerate the progress. However, addressing issues such as 'environmental and social accounting', 'triple bottom line', 'sustainability reporting', 'cleaner production', 'corporate social responsibility', or 'socially responsible investment' involves, on the one hand, the incorporation of basic concepts of sustainability in the teaching material of the courses. On the other hand, it implies the student's effort for assimilating and discussing around organizational practices

that go beyond the traditional model of business, developing skills to generate a critical and proactive view towards sustainability.

One important requirement to include these issues in the university context is to provide educators (professors) with mechanisms, resources and tools that allow the transmission of social and environmental concerns of our society to the students, obtaining as a result informed and responsible professionals in their fields of specialization.

Within this context, after analysing whether the students are familiar with the concepts of sustainability and social responsibility, this study will present successful learning experiences based on creativity, innovation and the use of Information and Communications Technologies (ICT)—e.g. service-learning or cooperative learning—to introduce the concept of sustainability in the area of business studies, and to promote a more responsible professional development of the university business students. Moreover, these experiences could help university educators to support their ESD professional development.

These innovative experiences have been applied in the Spanish University System. The findings of this research bring knowledge about the understanding of the sustainability concept in a high education context.

The rest of this paper is structured as follows. Section 2 reviews the theoretical background related to topics involved in the learning experience presented in this paper. In Sect. 3, it is described the experiences, presenting the activities and summarising the results. Finally, Sect. 4 presents the main conclusion of the study.

2 Theoretical Background

Sustainable development is defined as "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (WCED 1987). There are four dimensions in sustainable development—society, environment, culture and economy—which are intertwined, not separated. Universities have an important societal position as educational institutions for future professionals and may accelerate the change towards sustainable development (De Lange 2013). In the last decade, Higher Education System in Europe has been transformed and this could represent an opportunity to incorporate sustainability into the curricula of degrees and master degrees. In fact, a key issue of the Bologna Process is to prepare students for their future careers as well as to maximize their personal development and their contribution to a sustainable and democratic knowledge-based society.

However, until now, the basic contents included in business and finance education are the value of money, investment analysis, the cost of finance operations, weighted average cost of capital (WACC), portfolio management, markets and financial assets and operation of and relationships with financial institutions. Those

concepts are studied from a classical investment perspective, but considering the current socioeconomic situation, it is desirable for students to learn the new management possibilities that bear in mind more criteria than those only related to economic aspects. Sustainable development, corporate social responsibility (CSR) and socially responsible investing (SRI) have become some of the most prominent topics for researchers, business community, financial markets and society in recent years. Indeed, SRI has grown rapidly around the world, especially after the most recent global financial crisis.

In this regard, it is important for students of business and finance to change their curricula according to the new market demands. The rising demand of professional trained in aspects related to social responsibility, sustainability of organisations and sustainable finance justifies the introduction of the concepts of sustainable development, CSR and SRI in business and finance education. For instance, a student of business should know the concept of CSR, which is "*the voluntary integration of social and environmental concerns in their business operations and its relationships with partners*" (COM 2001) or as European Commission recently remarks "*the responsibility of enterprises for their impacts on society*" (COM 2011). Future managers should be more aware about the concept of sustainable development and CSR, since the implementation of CSR is becoming very necessary for survival in the changing business world. Likely, a student of finance should know the best practice for investors to incorporate CSR in their investment decision (Renneboog et al. 2008), which is SRI "*an investment discipline that considers environmental, social and corporate governance (ESG) criteria to generate long-term competitive financial returns and positive societal impact*" (US-SIF 2015). In fact, there are a growing number of investors seeking to stimulate the economic recovery in a more sustainable way. In this new scenario, SRI supports the emergence of a more sustainable economic system.

To afford aspects related to CSR and SRI, students should work harder on assimilating and reflecting on the concepts that go beyond the strictly economic and financial traditional vision, developing a critical and proactive spirit regarding sustainability. Students must fully understand the economic, social, governance and environmental impacts of the business if they wish to advance towards sustainable development (Galea 2004).

The integration of CSR into Higher Education is an ongoing process aimed at training professionals that search for the best possible relations between society, environment and business, taking into account aspects such as human development, human rights, justice, equity, and respect for diversity. In this respect, European Commission, in its 2011 report "*A renewed EU strategy 2011–2014 for Corporate Social Responsibility*", highlights the relevance of the integration of CSR in future learning programs for professionals.

Higher Education provides society with graduates able to combine knowledge with problem-solving capacities in the broadest sense. To include ESD in the university context, it is mandatory to provide professors with the necessary tools

and skills to transfer their knowledge into business opportunities; and to offer resources that they could use to teach and discuss sustainable development issues. To develop these capacities, during the learning process students should be involved in complex cases of the real world. In this educational context, the learning experiences based on creativity, innovation and the use of ICT could be successfully used to construct knowledge by working on complex problems together.

3 Method

Within this context, the first step in this research is to study the university students' perceptions about sustainable development, specifically about CSR and SRI issues and the need of including CSR and SRI concepts in the curricula of business students. To examine university students' perceptions, we conducted a field survey with a sample of business and finance students. Specifically, this study is addressed to the finance students of University Jaume I (UJI) in Castellón (Spain) during the academic year 2013–2014.

In the second step, after a deep analysis of the previously defined issues in business and finance education contents, innovative experiences were adopted to show students the role of the SRI in the financial markets and CSR in the companies. We designed five innovative experiences and projects to show students the role of the sustainable development in the financial markets and in the management of companies.

Specifically, this paper presents three innovative activities to show students the role of the SRI in the financial markets and CSR in the companies and two learning experiences in the Higher Education based on service-learning methodology and cooperative learning.

Table 1 shows the different proposed experiences related to the challenge of obtaining an education for sustainable development. Concretely, it presents the learning experiences performed associated to the aforementioned challenge and the current limitations identified to achieve it.

As Table 1 highlights service-learning and cooperative learning are potentially rich educational experiences. On the one hand, they allow students to understand the role of the SRI in the financial markets and CSR in the companies. On the other hand, they improve their personal, social, and critical thinking skills and develop the attributes required by university and for industry.

Cooperative learning has been defined as a "*small groups of learners working together as a team to solve a problem complete a task or accomplish a common goal*" (Artz and Newman 1990). Although the basic principles of cooperative learning do not change, there are several variations of the model. For example, Johnson and Johnson (1975) focus on developing a specific structure that can be incorporated with a variety of curriculum's, with an emphasis on integrating social skills with academic tasks.

Table 1 Learning experiences performed. General outline

Challenge	Implications for learning-teaching process		Current limitations	Proposals		Outcomes
	For teachers	For students		Subject	Experience	
Universities as accelerators for the change towards sustainable development	The incorporation of basic concepts of sustainability in the teaching material of the courses	Student's effort for assimilating and discussing around organizational practices that go beyond the traditional model of business, developing skills and attributes to generate a critical and proactive view towards sustainability present and for future generations	Scarcity of mechanisms, resources and tools that allow the transmission of social and environmental concerns of our society to the students	Sustainable Finance (Master in Sustainability and Corporate Social Responsibility)	Service-learning project	Knowledge and understanding Skills Attributes
				Financial and Bank Management (Diploma in Labour Relations)	Cooperative -learning	Knowledge and understanding Skills Attributes
			The basic contents included in business and finance education are studied from a classical investment perspective, without bearing in mind more criteria than those only related to economic aspects	Financial Operations Valuation (Finance and Accounting Degree)	The concern about sustainability aspects was considered in different lessons, introducing a sustainable profile in questions such as project finance, private equity assessment, or risks analysis.	Knowledge and understanding
				Operational Auditing (Finance and Accounting Degree)	Analysis of the relationships between operational auditing and sustainability and identification of weaknesses in the management systems related to CSR	Knowledge and understanding
				Treasury Management (Finance and Accounting Degree)	Introduction of the CSR and SRI concepts with the objective to implement the issue of sustainability into treasury management	Knowledge and understanding

Literature suggests that cooperative learning is a successful teaching strategy in which small teams, each with students of different levels of ability, use a variety of learning activities to improve their understanding of a subject. The educator chooses the groups to reflect a diversity of viewpoints, abilities, gender, race, and other characteristics. The groups contain fewer than six students—most likely four. Working with small teams of students contributes to unquestionable advantages to teaching (Domindo 2008).

Cooperative learning techniques have some advantages: (1) promote student learning, (2) increase student retention, (3) enhance student satisfaction with their learning experience, (4) help students develop skills in oral communication, (5) develop students' social skills, (6) promote student self-esteem, (7) help to promote positive race relations, etc.

As Stefaniak (2015) highlights, service-learning is a teaching-learning methodology that combines community service, academic coursework, and work-based experiential learning. In order to be considered as service-learning, the activity should comply with different features (Bringle and Hatcher 2009): (1) it must meet a need in the community, (2) its objectives should be aligned with the course objectives, and (3) it should integrate reflective practice for greater civic engagement and a better understanding of the course content.

Service-learning in Higher Education, "*is undergirded by a commitment to helping a putative homogeneous university student body learn more about themselves and others through engagement with presumed culturally, linguistically, socioeconomically different persons than themselves*" (Gomez et al. 2015). Moreover, service-learning projects can provide students with real-life experiences, so they can provide them with the opportunity to interact with clients and constraints that regularly occur on real-life work.

Service-learning techniques have some benefits for students and the community. For students: (1) makes curriculum relevant to students' lives, (2) clarifies values, (3) promotes community and civic responsibility, (4) develops critical thinking and social skills, (5) fosters social and personal development, (6) enhances student satisfaction with their learning experience, (7) helps students develop skills in oral communication etc. For the Community: (1) provides meaningful services to the community, (2) creates opportunities for community to participate in student learning, (3) builds community awareness of college programs and services, etc.

Previous examining the results, this research should present the limitations of the method. One the one hand, cooperative-learning is not always a successful technique for groups of mixed ability, since low-achieving students become passive and do not contribute to the group. In addition, the conflicts between members of a group can diminish a group's ability to work in a cooperative way. On the other hand, service-learning project could not be aligned with the subject (time and curricula), the teacher expertise, or the students' expectations, factors that affect the effectiveness of this technique.

4 Results

4.1 Survey Results

As we have previously stated, in an initial stage, we were interested in finding out whether the students of business and finance are familiar with the concept of sustainable development, specifically about CSR and SRI, and whether or not they are part of their knowledge, their degree programmes, and in their professional and personal future.

We conducted a field survey with a sample of business and finance students and we analysed three cases—where CSR and SRI were included—in three subjects: (1) Financial Operations Valuation, (2) Operational Auditing and (3) Treasury Management.

Once collected and tabulated the questionnaires, some interesting findings can be remarked. As it is observed in Table 2, there is a high percentage of students who consider important to include social responsibility issues in their degree's subjects. Furthermore, the 83 % of students state that training on ethical or social responsibility knowledge would allow them to perceive that business decisions are imbued with moral and ethical implications.

As Table 3 shows, it is remarkable the high percentage of students that have answered "Don't know" in the questions about socially responsible investment. Only the 42 % have heard about socially responsible investment before. The rate

Table 2 Responses to questions about corporate social responsibility subjects

	Yes (%)	No (%)	DK (%)
Do you consider important to address social responsibility issues in any of your degree's subjects?	73.15	20.81	6.04
Do you consider if students received training on ethical or social responsibility contents, it would allow them to perceive that business decisions are imbued with moral and ethical implications?	83.22	7.38	5.37

Table 3 Responses to questions about socially responsible investment knowledge

	Yes (%)	No (%)	DK (%)
Have you heard about Socially Responsible Investment?	42.74	36.75	20.51
Have you ever hired a financial product Socially Responsible?	11.11	64.10	24.79
Do you know what is ethical banking?	35.04	42.74	22.22
Do you know any international ethical bank?	46.15	0.00	53.85

decreases to 11 % when they are asked if they have ever hired a socially responsible financial product. These figures underscore the lack of knowledge that students have about socially responsible investment.

This lack of knowledge is also evident when they are asked about the ethical banking concept. Most students do not know this concept and they are unaware that exists a wide range of international ethical banks.

4.2 Learning Experiences

Second phase was about reviewing the practical materials used in previous courses in order to adapt them to the introduction of CSR and SRI concepts. One of the most difficult tasks to carry out during this project was the integration of SRI and CSR among the traditional contents of business management in a practical manner.

As discussed earlier, we designed three innovative activities and two learning experiences to show students the role of the sustainable development in the financial markets and in the management of companies. These activities were used in five business subjects: (1) Financial and Bank Management, (2) Sustainable Finance, (3) Financial Operations Valuation, (4) Operational Auditing, and (5) Treasury Management.

Specifically, this study is addressed to: (1) students of the third course of Diploma in Labour Relations (2002 Programme of Study) of UJI; (2) students of the Master in Sustainability and Corporate Social Responsibility, which is offered by UJI and Spanish National University for Distance Education (UNED); and (3) the finance students of UJI.

4.2.1 Financial and Bank Management

It is a second semester optative subject of the third course of Diploma in Labour Relations (2002 Programme of Study), but also an elective subject for other degrees. The main objective of the Financial and Bank Management subject is to provide the students with the basics of financial management techniques, paying special attention to the techniques for investments evaluation, finances management and banking institutions engagement. In this context, the debate surrounding the questions related to SRI and sustainable financials in banking and organizations is considered a very important topic. These concepts were integrated by means of an innovative methodology based on the cooperative learning. The working teams were integrated by three or four students from different grades.

The project developed by the students involved writing an Executive Report about the sustainability of two financial entities (different for each working group) belonging to banking industry—a bank and a savings bank. Specifically, each working team was required to analyse and compare two Sustainability Reports of

banking institutions. In their reports students had to analyse the social and environmental information as well as the traditional economic-financial information.

The results indicate that the students have increased their motivation in the subject, and their comprehension of sustainable finance.

4.2.2 Sustainable Finance

It is a second semester optional subject of the Master in Sustainability and Corporate Social Responsibility. This Master is online, therefore, the Information and Communications Technologies for learning is a transversal subject integrated in the Programme. The basic contents of this subject are aimed at allowing students to identify and anticipate potential risks and points of friction between the economic-financial sphere and the social, environmental and sustainability considerations; to suggest alternatives as possible solutions to the problem; to make decisions autonomously in a context of uncertainty; and to learn the new investing possibilities that bear in mind more criteria that those only related to economic aspects.

By means of a service-learning project, it has been introduced in the subject the debate surrounding the investor's financial needs and investment's impact on society.

In this service learning project, after learning about SRI and studying their local community financial problems and needs, students had to adopt a role as a 'consultant' and they should develop a financial solution. Specifically, they had to create a community investment vehicle to the local community. This proposal gave students experiential opportunities to learn in real world contexts and develop skills of community engagement.

First, students did a personal fieldwork and investigated the financial needs and realities of their local community or certain groups (farmers, people that live in a rural area, women, young people, unemployed, etc.). Second, after the fieldwork, students designed a community investment vehicle to facilitate the social integration and inclusion in the financial system of persons from excluded social categories. The basic issues included in the report were: (1) Contextualization of the problem or need in the community for which it is to design the investment vehicle; (2) Definition of the community investment vehicle; (3) Main characteristics and objectives of the community investment vehicle; (4) Major beneficiaries; and (5) Overall impact on society in economic, social or environmental terms.

The projects developed by students had a high level of quality and consistency, what helped them to internalize the concepts they had developed during the course. The Example 1 shows the main characteristics of the vehicles designed by students, where some of the most important SRI principles can be observed.

Example 1 Main characteristics of community investment vehicle

Characteristics of community investment vehicle	
Objective	To promote sustainable development refinancing micro-entrepreneurs in a local community
Investment policy	Hedge fund characterized by investments in any unlisted securities issued by microfinance institutions or other securities or instruments issued in order to finance the activities of such institutions
Category	– Type of fund: hedge fund – Scope of the fund: Spain
Investors	Individual and institutional investors, funds of funds sufficiently aware or sensitive to the concept of socially responsible investment and sustainable development
Structure	– ASG/Ethics Committee, with 50 % of independent experts and NGOs – Evaluation criteria: socio-labor, environment and community relations – Investment quarterly post-checks are performed

Students work on real financial problems makes academic learning relevant while simultaneously enhances their social skills, analytical ability, civic and ethical responsibility, self-efficacy, and career development.

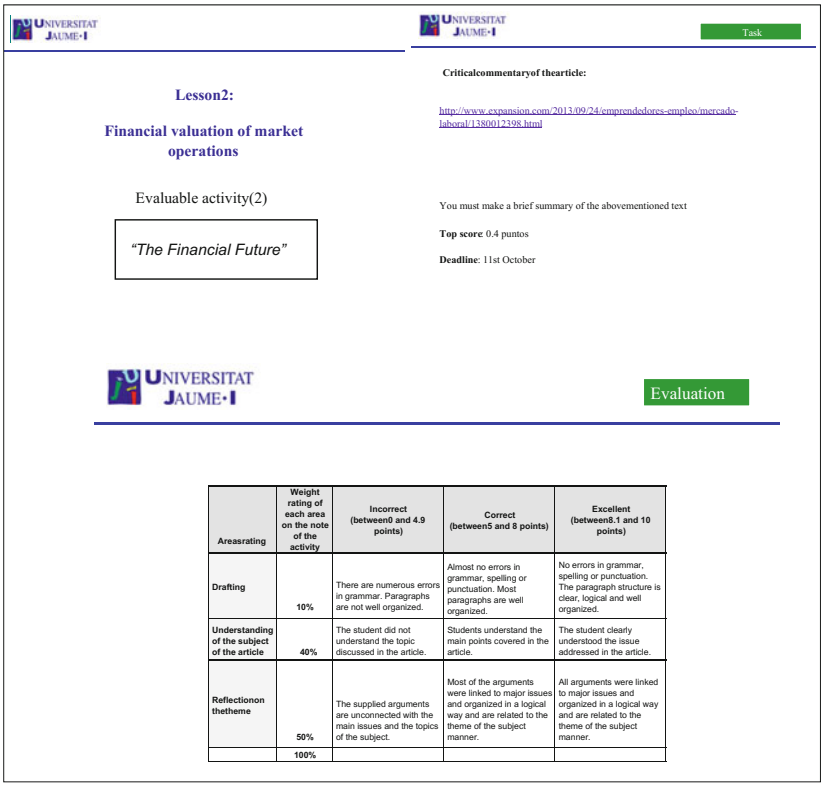
Results indicate that the students have increased their motivation in the 'Sustainable Finance' subject, and their comprehension of sustainable finance. The students expressed the new methodology made it easier for them to develop some interpersonal skills such as reasoning, critical reflection, problem solving, public speaking and others, as well as personal qualities such as responsibility and integrity.

4.2.3 Financial Operations Valuation

It is an optional subject in the fourth course of Finance and Accounting Degree. The concern about social, governance and environmental aspects was considered in different lessons, introducing a sustainable profile in questions such as project finance, private equity assessment, or risks analysis. The students' perception about the importance of the integration of environmental, social and governance aspects into the business management traditional models was generally positive. They expressed their opinion in an activity specifically designed for this project, analysing an article about de financial profession in the future (Example 2).

The most part of the students agree with the necessity of learning in sustainable business management tools, especially those applied to financial markets and banks activities and products.

Example 2 Example of activity



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Lesson2:

Financial valuation of market operations

Evaluable activity(2)

"The Financial Future"

UNIVERSITAT JAUME·I

Task

Criticalcommentaryof thearticle:

http://www.expansion.com/2013/09/24/emprendedores-empleo/mercado-laboral/1380012398.html

You must make a brief summary of the abovementioned text

Top score 0.4 puntos

Deadline: 11st October

UNIVERSITAT JAUME·I

Evaluation

Areasrating	Weight rating of each area on the note of the activity	Incorrect (between0 and 4.9 points)	Correct (between5 and 8 points)	Excellent (between8.1 and 10 points)
Drafting	10%	There are numerous errors in grammar. Paragraphs are not well organized.	Almost no errors in grammar, spelling or punctuation. Most paragraphs are well organized.	No errors in grammar, spelling or punctuation. The paragraph structure is clear, logical and well organized.
Understanding of the subject of the article	40%	The student did not understand the topic discussed in the article.	Students understand the main points covered in the article.	The student clearly understood the issue addressed in the article.
Reflectionon thetheme	50%	The supplied arguments are unconnected with the main issues and the topics of the subject.	Most of the arguments were linked to major issues and organized in a logical way and are related to the theme of the subject manner.	All arguments were linked to major issues and organized in a logical way and are related to the theme of the subject manner.
	100%			

4.2.4 Operational Auditing

It is an optional subject in the fourth course of Finance and Accounting Degree. This subject addresses corporate governance processes, risk management and internal control mechanisms. Concepts related to sustainability and CSR were integrated in the different lessons of the subject. Moreover, the students presented a task where they had to analyse recent business failures and identify three weaknesses related to the management process. A large number of students concluded that important factors of the business failures had been a lack of analysis, assessment and control of financial and extra-financial variables such corporate governance, social and environmental variables, and a lack of transparency in the information systems of the firm.

As a result, the students understood the relationships between operational auditing and sustainability and identified several weaknesses in the management systems related to CSR.

4.2.5 Treasury Management

It is an optional subject in the fourth course of Finance and Accounting Degree. Topics covered include issues such as treasury functions, treasury performance measurement, liquidity management systems and controls. It was devoted some time during the classes to introduce the CSR and SRI concepts with the objective to implement the issue of sustainability into treasury management. Moreover, students had available additional documents to incorporate the concept of sustainability into treasury management in small and medium enterprises (SMEs). The main objective of these documents was to show the necessity that this business area engages in long-term sustainable development in the companies through practical examples.

As a result, the students understood the importance of implementing CSR polices in all business areas across the companies.

5 Conclusion

Achieving sustainable development will not be possible without the effective integration of education for ESD at all educational levels. The introduction in Higher Education teaching programs a debate around issues of sustainability and social responsibility in organizations may not necessarily involve changing the curriculum, it may in some cases involve minor adaptation, or different ways of approaching issues.

In this context, this paper presents successful learning experiences to introduce the concept of sustainability in the area of business studies, and to promote the university business students' professional development in a more responsible way. Consequently, this study provides university educators with tools which allow them to introduce in the teaching programs a debate around issues of sustainability and social responsibility in organizations related to financial management.

The above mentioned experiences can be applied in all subjects included in the area of Accounting and Finance. We have tried to provide learning resources in terms of management organizations within the parameters of sustainability and corporate social responsibility, in addition to the traditional economic and financial vision that students acquire in studying financial issues. In a globalized, complex and changing environment, the management of information helps to minimize risks, and manage the organization's relations with its stakeholders under a triple economic, social and environmental dimension could be framed within that integrated risk management. Therefore, as a result of experience, we hope to have contributed to the personal and professional development of students.

The main lessons of this research bring knowledge about the understanding of the sustainability concept in a high education context. Moreover, this paper offers some guidelines that could be used by Higher Education Institutions, in order to introduce the sustainability concept in the business curricula; and provide some resources that support ESD professional development of university educators.

From the experience gained through the activities of this project, we believe that it will be interesting to pose a future educational innovation project in which some of the methodological and formal aspects observed in the teaching of other subjects are implemented. For example, teaching methodologies related to cooperative learning would not only be of great interest to the teaching of such issues, but also would provide an approach fully consistent with CSR management.

However, the incorporation of aspects-related to the concepts of CSR, SRI and sustainability in Spanish Higher Education is a slow and gradual process due to the inflexibility of the Spanish Education System. Further tools and experiences are clearly needed for promoting sustainable development in Higher Education.

This study opens new questions that can be addressed in future research. First, future studies could go in depth into the factors of universities that affect the progress towards sustainable development. Second, future research may extend the initial analysis considering the teachers' perceptions on CSR and sustainability. Third, the learning experiences presented in this study may be replicated in other degrees and areas of knowledge since sustainability and CSR are interdisciplinary concepts.

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Authors Biography

Dr. Elena Escrig-Olmedo is a Ph.D. in Sustainability of the Organisations (2013) from the University Jaume I (Castellon, Spain). Currently, she works as an Assistant Lecturer at the Finance and Accounting Department of the University Jaume I, Spain.

Her research focuses on Sustainable Finance, Corporate Social Responsibility Management and Social and Environmental performance measurement. The results of this research have been published in a number of high-impact international academic journals.

Her teaching profile is associated to the area of Finance and Accounting, and includes teaching at undergraduate (Degree in Finance and Accounting, Degree in Economics, Degree in Business Administration) and postgraduate (Master in Sustainability and Corporate Social Responsibility).

Professor María Ángeles Fernández-Izquierdo received a Ph.D. in Financial Economics and Accountancy (1991) from the Universidad de Valencia. She is a Full Professor in Finance and Accountancy, Universitat Jaume I, Spain and a member of the Spanish Institute of Financial Analysts. From 1981 to 1987, she held a position as an Economist in the Valencia Stock Exchange.

Her research focuses on efficiency, microstructure and hedging in stock markets and their derivatives, ethical investment and corporate social responsibility and has published scientific papers in high-impact international academic journals.

She is currently a Faculty Member in postgraduate courses related to corporate finance, financial markets and sustainable finance.

Dr. Idoya Ferrero-Ferrero is Ph.D. in Financial Economics and Accounting (2012) from the Universitat Jaume I. Currently, she works as an Assistant Lecturer at the Finance and Accounting Department of the University Jaume I, Spain.

Her current research interest lies in corporate governance, banking industry, and CSR areas. She has taken part in several international congresses, and published academic papers in international academic journals.

She also teaches corporate governance and accounting related subjects at postgraduate and undergraduate levels.

Dr. Raúl León-Soriano is an Assistant Lecturer in Finance in the Department of Accounting and Finance in the University of Zaragoza. He received the B.S., degree in Computer Engineering for Business Management from the University of Zaragoza, Spain, and the M.S. and Ph.D. degrees in Computer Engineering, and the M.S. degree in Finance and Accounting from the University Jaume I of Castellón, Spain.

His research is focused on enterprise information systems, business strategic planning and management, modeling and simulation of the business process and the integration of corporate social responsibility into business strategies and information systems.

Professor María Jesús Muñoz-Torres is a Ph.D. in Agricultural Economics from the Polytechnic University of Valencia (1994). She is a Professor in Finance in the Department of Finance and Accountancy, Universitat Jaume I, Spain and a member of the Spanish Institute of Financial Analysts.

Her research focuses on Corporate Social Responsibility valuation, Socially Responsible Investing, sustainable efficiency of public financial support to companies, stock markets and their derivatives, and has published scientific papers in high-impact international academic journals.

She is currently a faculty member in a number of postgraduate courses related to CSR and development and corporate finance.

Dr. Juana María Rivera-Lirio is a Ph.D. in Business Management from the Jaume I University of Castellón. Currently, she works as Permanent Lecturer at the Finance and Accounting Department of the University Jaume I, Spain.

Her research focuses on Sustainable Finance, Corporate Social Responsibility Management, Sustainability Assessment and efficiency of public financial support to Companies.

Her teaching profile is associated to the area of Finance and Accounting, and includes teaching at undergraduate (Degree in Finance and Accounting, Degree in Economics, Degree in Business Administration) and postgraduate (Master in Sustainability and Corporate Social Responsibility and Master in Occupational Hazards).

Fauna Protection in a Sustainable University Campus: Bird-Window Collision Mitigation Strategies at Temple University

Katherine Switala Elmhurst and Kathleen Grady

Abstract

Philadelphia resides along the Atlantic Flyway bird migration route, and each spring and fall thousands of birds pass through Temple University. Campus buildings, especially those with highly reflective or transparent window glass, are prone to bird collisions. Birds do not see glass as a solid object, rather a reflection of their habitat or nothing at all. Birds collide with the windows and either die from impact or are injured and become easy prey. Utilizing student problem- and project-based learning (PPBL) opportunities, Temple University identified collision hotspots and implemented mitigation strategies, such as decorative window film, to reduce campus bird strikes. Temple also created awareness about its efforts to reduce bird deaths through collaborative projects, art installations, presentations and media coverage. This paper provides a case study of one urban university's efforts to address bird-window collisions through independent research, curriculum infusion projects and campus awareness campaigns. The paper also provides recommendations for future research and work.

Keywords

Bird-window collisions · Mitigation strategies · Bird strikes · Problem- and project-based learning · Sustainability

K.S. Elmhurst (✉) · K. Grady
Office of Sustainability, Temple University, 1755 N. 13th Street,
Philadelphia, PA 19122, USA
e-mail: kelmhurst@temple.edu

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1 Introduction

Within the last 15 years, institutions of higher education have emerged as key stakeholders in the push for a more sustainable future. While their initial focus was on greening operations (Carlson 2015), colleges and universities have since embraced their role of developing a corps of sustainability professionals. New coursework and co-curricular activities have been developed to prepare students for their role as change agents and members of the sustainability and resiliency workforce (Heiskanen et al. 2015; Rowe 2007). While some universities are developing centralized sustainability science programs within a dedicated school or college, other institutions are incorporating sustainability into the curriculum in a patchwork manner, inserting it into existing degree programs (Barlett and Eisen 2002; Chase and Rowland 2004; Wiek et al. 2014).

Although the structure of sustainability programs varies, there is a consensus that problem- and project-based learning (PPBL) should play an integral part in sustainability curriculum (Heiskanen et al. 2015; Rowe 2007; Savery 2006; Wiek et al. 2011, 2014). PPBL challenges students to tackle real world problems as a means of developing their critical thinking, content knowledge and soft and hard skills (Brundiers and Wiek 2013; Heiskanen et al. 2015; Savery 2006; Wiek et al. 2011, 2014). PPBL can take a variety of forms, including workshops, seminars, independent studies, research projects, entire courses and components of a broader course (Wiek et al. 2014).

This paper presents a case study of sustainability PPBL activities focused on the problem of bird-window collisions within the built environment at Temple University, an urban research university located on the Atlantic Flyway bird migration route. Using bird strikes as the framework, Temple University engaged students from across disciplines in PPBL to learn about issues of habitat, conservation and sustainable design. This case study offers an example of how PPBL in research, curriculum and co-curricular activities can prepare students for their future role as sustainability professionals while also leading to tangible change on campus.

2 Pedagogical Context

Sustainability as an academic discipline and degree program is relatively new to higher education. In their exploration of how to integrate sustainability into the curriculum, faculty members are looking for educational tools that capture the students' imagination and draw them into the material. PPBL is one such tool that advances content knowledge by challenging students to assess and address real world scenarios (Barrows and Tamblyn 1976; Heiskanen et al. 2015; Rowe 2007; Wiek et al. 2011, 2014).

While sharing similar benefits, problem-based learning and project-based learning engage students in different ways. In problem-based learning, the teacher presents students with a real world challenge and asks them to examine the

underlying causes of the problem, propose solutions and identify the consequences of those solutions (Brundiers and Wiek 2013; Wiek et al. 2014). Through self-guided investigation, students gain an understanding of the complexity posed by the problem, but typically limit their journey to reframing the problem and identifying solutions, rather than testing their hypotheses (Brundiers and Wiek 2013; Wiek et al. 2014). If the problem is more personally or socially relevant, students exhibit higher levels of comprehension of the material (Albanese and Mitchell 1993).

In contrast, faculty members employing project-based learning ask their students to develop actionable interventions in an identified case. Through the lens of one project, students analyze and define a problem, develop practical solutions and test their proposed solutions (Brundiers and Wiek 2013; Wiek et al. 2014). Since the students are often working with "real world" clients, project-based learning is typically more structured around the development of implementation opportunities (Brundiers and Wiek 2013; Wiek et al. 2014).

The benefits of PPBL include: (a) engagement of students in real world problems; (b) students ownership over their learning; (c) exposure to their future professional field; (d) development of hard and soft skills necessary to succeed in the workplace; and (e) integration of past and current learning (Brundiers and Wiek 2013; Heiskanen et al. 2015; Savery 2006; Wiek et al. 2011, 2014).

3 Sustainability and PPBL

PPBL lends itself to sustainability education by building the core competencies needed to be a sustainability change agent. Wiek et al. (2011, p. 213) outline the core competencies as follows:

- Systems-thinking;
- Interpersonal skills, such as conflict resolution, leadership, and communication;
- Strategic competences, such as planning, organizational change management, and decision making;
- Anticipatory competences, including the ability to project consequences; and,
- Normative competences, such as mission-focus and accountability.

Future sustainability professionals will need to be able to navigate across disciplines, engage and communicate with various types of stakeholders, and contextualize their work within various constraints. These skills cannot be gained through books and lectures, but rather require hands-on learning (Wiek et al. 2014). Through PPBL, students can deepen their content knowledge while strengthening their hard and soft skills (Heiskanen et al. 2015; Wiek et al. 2014).

Faculty members also utilize PPBL to integrate sustainability into non-STEM and non-sustainability fields by partnering it with curriculum infusion efforts. As a pedagogical tool, curriculum infusion introduces students to new intellectual

content by integrating it into their current coursework discipline (Chase and Rowland 2004). By meeting students where they are at, sustainability practitioners weave important environmental concepts into existing coursework through targeted projects and experiential learning opportunities. Using PPBL, both students and faculty embark on the learning journey together, as they explore new academic material and apply it to their discipline of focus (Chase and Rowland 2004). Outside of their area of expertise, faculty members turn to sustainability experts to provide guidance and thought leadership on the topic in question.

4 PPBL and Bird-Window Collisions

In 2010, Temple University adopted a Climate Action Plan, which set forth goals for incorporating sustainability into undergraduate education. Three principles informed the plan's discussion of undergraduate curriculum: "(a) sustainability education should feature hands-on experiences that connect students with local issues, community organizations, and problem settings when applicable; (b) program elements should be as flexible and inclusive as possible; and (c) there is a strong need for new, interdisciplinary courses at Temple" (O'Brien and Gere 2010, p. 44). Since its adoption, the university's Office of Sustainability has partnered with numerous academic departments to utilize the campus as a living learning laboratory and as a basis for PPBL sustainability curriculum modules. One prominent, interdisciplinary example of the implementation of PPBL focused on addressing bird-window collisions with university buildings.

Temple University and other areas of Philadelphia have been plagued with bird mortalities (Fig. 1). Temple's Main Campus is situated along the Atlantic Flyway migration route and bird collisions with its buildings are noted annually, especially during the spring and fall migration seasons (typically mid-March through mid-June and mid-August through November). According to Audubon, forty percent of bird species that migrate along the Atlantic Flyway are in conservation need (Audubon 2011). Therefore, creating a safe campus habitat for both migrating and local birds has become an important issue.

The occurrence of bird collisions with campus buildings was an emotionally charged problem that attracted the attention of students across disciplines. Disturbed by the presence of dead or injured birds, students viewed the bird strikes as an urgent problem facing the university that they wanted to address. The issue of bird strikes within the built environment presented an opportunity to engage students in PPBL, as research indicated that if the problem is more personally or socially relevant, students exhibit higher levels of comprehension of the material (Albanese and Mitchell 1993). The university harnessed the pathos associated with the collisions to create sustainable curriculum opportunities on campus. Temple's Office of Sustainability worked with departments and student organizations across campus to develop PPBL-based independent research, curriculum infusion and co-curricular opportunities related to bird strikes.

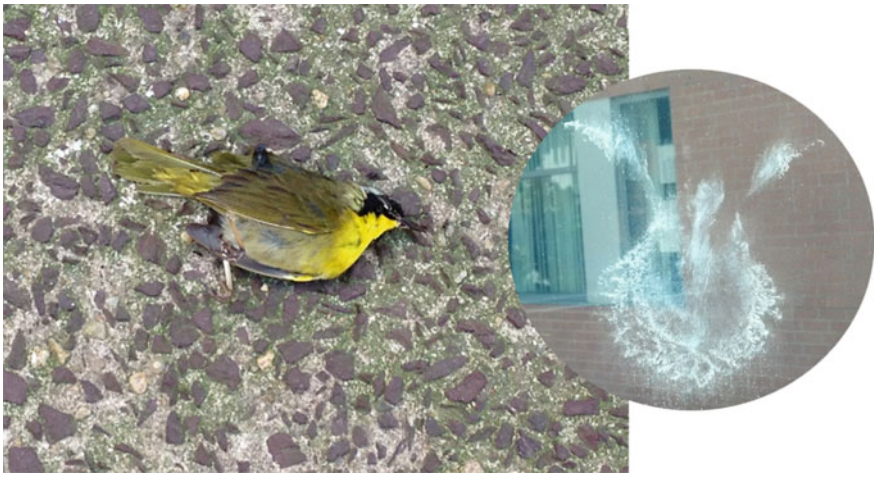

Fig. 1 Bird causalities due to collisions with Temple University campus building windows

5 Bird-Window Collisions: A Sustainability Issue

According to the American Bird Conservancy, "collision with glass is the single biggest known killer of birds in the United States, claiming hundreds of millions or more lives each year" (Sheppard 2011, p. 5). It is estimated that between 300 million and one billion birds die each year in the United States due to building collisions, with the majority of deaths occurring at low-rise buildings (Loss et al. 2014b). Studies have revealed a direct relationship with glass and bird strikes and bird-window collisions have intensified with the increased use of glass in the building industry (Sheppard and Phillips 2015). Collisions with windows are a major problem for migrating and local bird populations worldwide because they do not perceive reflective or clear glass as a solid object; they see a reflection of their habitat or nothing at all (Klem 2006). The majority of birds that collide with windows either die from impact or are injured and become easy prey (Klem 2015).

Understanding the nature and magnitude of bird strikes prior to implementation of mitigation strategies is important because detecting a clear pattern of bird strikes can be challenging (Hager and Cosentino 2014; Klem 2006). Collisions can occur when birds and glass coexist, and every building poses its own set of collision risk factors due to design, siting and location (Klem 2006; Klem et al. 2009; Sheppard and Phillips 2015).

6 Bird Strike Monitoring

In an effort to understand the nature of bird-window collisions at Temple University's Main Campus, monitoring programs were established to document bird strikes. Leveraging the benefits of PPBL, student staff at Temple's Grounds

Maintenance department conducted the first monitoring program during the 2004–2005 academic year after noticing increased bird fatalities near campus buildings during migration seasons. The purpose of the monitoring program was to determine which buildings were the most collision prone. Forty-six buildings were monitored both in the early morning and late afternoon from October 15 to November 16, 2004, and May 31 to June 15, 2005. While neither count reflected a full migration season, over 200 bird fatalities were documented.

Recognizing a need for additional monitoring on Temple's Main Campus, Audubon Pennsylvania and the Philadelphia Zoo organized a survey of bird collisions in 2009 in conjunction with Temple University. This survey monitored 12 campus buildings that were thought to be the most collision prone based on initial monitoring efforts. Student volunteers collected data from April 20 through May 27, 2009, and documented 53 bird collisions (Russell 2011). The survey noted that buildings with the highest incidents of bird strikes occurred at buildings with highly reflective or transparent glass with the following buildings accounting for seventy-five percent of documented collisions:

- Howard Gittis Student Center: Large amount of highly reflective glass and situated next to trees;
- Ritter Hall: Modest amount of reflective and transparent glass and surrounded by trees and shrubs;
- Tech Center: Large amount of highly reflective glass and surrounded by trees and shrubs along the north and west sides;
- Paley Library: Reflective and transparent recessed windows;
- Alter Hall: Large amount of highly reflective glass with trees along the south side;
- Beury Hall: Large amount of highly reflective and transparent glass, surrounded by trees and shrubs and a transparent glass walkway.

The 2004–2005 and 2009 monitoring surveys both indicated that the most collision prone buildings were those with highly reflective or transparent glass, and vegetation situated close to windows seemed to exacerbate collisions (Russell 2011). Research also indicates that there are likely more bird fatalities than can be documented by monitoring efforts because some strikes leave no visible evidence (Klem 2014). At Temple, inaccessible areas, such as dense vegetation or roof overhangs, can conceal dead or injured birds, and urban scavengers may carry bodies away before they are discovered.

Since 2009, campus monitoring for bird-window collisions has continued on campus through the efforts of Grounds Maintenance student staff, student researchers and student volunteers. In addition to the collision prone buildings documented in earlier monitoring surveys, students found that buildings constructed after initial monitoring efforts that have utilized large expanses of glass (Architecture, Science Education and Research Center and Tyler School of Art) also appear to be problematic for bird collisions.

From 2004 to 2013, over 750 bird strikes, representing 40 different bird species have been documented on Temple's Main Campus through student monitoring PPBL activities.

7 Mitigation Strategies

Monitoring data revealed that developing solutions to mitigate bird strikes with campus windows are needed to help reduce collisions. The first mitigation strategy to be implemented at Temple was the installation of Hawk models. Eight, two-dimensional life-sized hawk models, developed by Keith Russell of Audubon Pennsylvania, were mounted on four collision prone buildings in the spring of 2010. Because songbirds have an innate fear of bird-eating hawks, Russell wanted to test the theory that realistic models could prevent bird strikes. While it was determined that hawk models were not successful at reducing bird strikes, this project opened the door to student PPBL opportunities by using the bird-window collision issue as a case study to try other mitigation strategies.

7.1 Independent Research

The first student research project to study campus bird-window collisions was conducted by Haley Gilles in 2011. Using funds received through Temple's Creative Arts, Research and Scholarship (CARAS) program, the project aimed to test the effectiveness of a low-cost window film option on a collision prone campus building. Following certain guidelines, patterned window film helps alert birds to the presence of glass and has been used successfully to mitigate bird strikes on other buildings, such as the Philadelphia Zoo (Sheppard and Phillips 2015). After reviewing past monitoring data, Gilles selected a glass walkway located on the west side of Beury Hall. This corridor was determined to be a prime location because it offered a small study area to make the project cost effective, and it was a known collision hotspot for birds due to glass transparency (Russell 2011). Gilles and student volunteers monitored the area prior to installing window film during the spring migration period (April 14 to May 13, 2011). During the summer of 2011, Gilles cut and installed film in the shape of 4 in. by 4 in. squares spaced 8 in. apart along the east side of the Beury glass corridor. Although research has shown that songbirds will avoid flying through spaces that are 2 in. high or less and 4 in. wide or less, referred to as the "2 × 4 Rule" (Sheppard and Phillips 2015, p. 47), Gilles opted to test a wider spacing in order to maintain a larger window viewing area for occupants. The area was then monitored during the fall migration period for bird strikes (September 1 to October 30, 2011). The results revealed that the spacing of the squares was not 100 % effective at reducing bird strikes leading Gilles to conclude that the study was not comprehensive enough to determine the effectiveness of the window film pattern applied.

Another student-led research project aimed to test the effectiveness of crop netting to prevent bird-window strikes. Window netting helps mitigate bird deaths and injuries resulting from striking the hard window surface by allowing birds to bounce off a taut net (Cornell Laboratory of Ornithology 2004). Crop netting had been successfully used to remedy the bird collision problem at Cornell's Lab of Ornithology (2004). With funding from CARAS, Alexis Kessler proposed to install and test window netting as a removable and affordable alternative to window film. Kessler selected the same Beury Hall glass walkway used in the 2011 Gilles study because it offered a small, cost effective test area and extensive monitoring data was available for the site. With help from Grounds Maintenance, crop netting was installed on both sides of Beury Hall's glass walkway in April 2013 (Fig. 2). Prior to the installation of the crop netting, the window film installed by Gilles in 2011 was removed. Monitoring conducted by Kessler after netting installation revealed that it was effective at mitigating bird strikes as dead or injured birds were not found at the base of the corridor's windows.

Compelled to address the bird-window collision problem on campus, Gilles and Kessler engaged in self-directed study of the global problem of bird collisions within the built environment. Through this problem-based learning model, the students felt empowered as experts in this field, viewing their studies as part of the larger dialogue on bird strikes. They remained in regular contact with thought leaders from the local Audubon chapter and the Philadelphia Zoo, and worked to raise awareness of the issue on campus. For example, Gilles conducted tabling at Campus Sustainability Day during which she exhibited specimen of the dead birds collected on campus, shared her data and proposed her solution to her peers. Both students were regularly interviewed for the student newspaper on their work, and they served as de facto peer educators on the challenge presented by glass

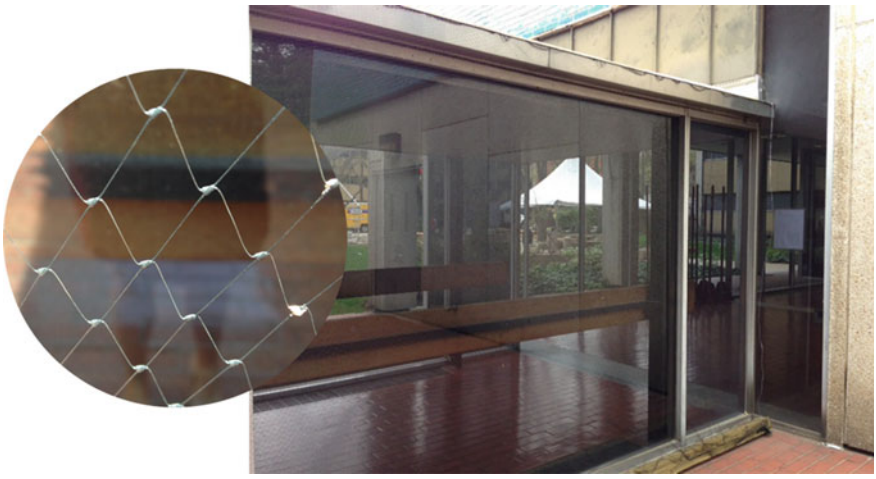

Fig. 2 Crop netting installed at Beury Hall

buildings. At the conclusion of their respective projects, both students remained involved with the issue on campus, feeling invested in the course of study and the implementation of solutions. After graduation, Kessler obtained full-time employment at a bird rehabilitation facility.

7.2 Curriculum Infusion

At Temple, the problem of bird-window collisions catalyzed the first of a series of curriculum infusion partnerships between the Office of Sustainability and the Tyler School of Art. The Department of Graphic and Interactive Design (GAID) encouraged faculty members in the department to develop an assignment that required students to design window film that was both aesthetically appealing and effective in preventing bird collisions. Over the course of one semester, faculty members and students in GAID researched the current problem of bird strikes, best practices for mitigating bird strikes and design parameters that have been proven effective for window film designs. The class culminated with a juried "Bird's Eye View" design competition where over 90 window film designs were submitted by students. The winning design from Molly Denisevicz was subsequently installed on the Tuttleman-Paley glass connector bridge in January 2014 (Fig. 3). Known as a collision hotspot, the window film at Tuttleman-Paley has proven to mitigate bird strikes. The success of this project led to the installation of window film at two other collision-prone buildings in August 2015.

While the course was focused on teaching graphic design principles, students in the participating classes gained a deep understanding of sustainability and specifically the issue of bird collisions on campus. As a result of the effectiveness of this

Fig. 3 "Bird's Eye View" winning design installed at the Tuttleman-Paley connector bridge

initial competition, GAID partnered with the Office of Sustainability to create a similar assignment around energy conservation messaging during the following fall semester.

The "Bird's Eye View" initiative also helped raise awareness on campus and in the region, which is afflicted with the same problem of bird collisions. The project garnered press for both the graphic design competition and window film installation in various media outlets (Audubon 2012; Brown 2014; Nuwer 2012).

7.3 Co-curricular: Campus Awareness Campaigns

Creating awareness of bird-window collisions has been an important aspect of mitigation efforts undertaken on campus. Through collaborative efforts, news articles, informational signage and presentations, Temple is spreading the word about threats facing migratory birds and building support for mitigation efforts. Student organizations have been active partners in awareness campaigns and the following examples illustrate how the university harnessed PPBL in co-curricular activities to address bird-window collisions on campus.

Temple's Office of Sustainability provides administrative support to the Green Council, a collective of sustainability themed student organizations that work to foster partnerships and collaborations across the groups. The individual organizations have differing missions, but they work together to advance sustainable culture change on campus. In spring 2014, members of the Green Council sought to address bird strikes on campus by raising awareness of the problem and building support for campus interventions. Upon learning more about the problem, the Green Council organized a public discussion with experts on campus bird strikes and mitigation efforts as part of their "Potluck with a Purpose" series. The event drew over 80 attendees and coincided with the migration season. The Green Council encouraged the audience to contact university administration about adopting a bird-friendly design standard and implementing mitigation techniques.

In spring 2015, students in the Tyler School of Art built on the Green Council's efforts and developed a site-specific awareness campaign. Faced with dead or injured birds when entering the Art and Architecture buildings, students explored the issue and decided to develop a project to raise awareness of the threat their academic building posed to migrating birds. The Tyler students collected and mapped bird strikes with their building. They then organized and sponsored an art exhibit featuring conceptual designs for building facades aimed at mitigating bird collisions, photography of injured birds and an open call for ideas on how to address this problem on campus. Academic classes toured the exhibit and the Temple student newspaper published a news story about the exhibit.

In fall 2015, students on campus formed Bird Temple, a student organization aimed at calling attention to bird deaths on campus. The organization formed a task force of students, staff, faculty and outside experts to develop plans to address bird strikes with campus buildings. The organization also tabled during the Campus

Sustainability Day green fair and is organizing a bird migration festival to celebrate the lives of birds and bird habitat on campus.

Co-curricular activities have been instrumental for PPBL by reaching beyond the classroom to give students the opportunity to develop critical leadership and strategic skills, core competencies needed to be a sustainability change agent.

8 Conclusions

The challenge of bird-window collisions on campus has informed the dialogue about the advancement of sustainability learning objectives at Temple. The impact of bird strikes is witnessed regularly by students—students walk by dead or injured birds as they enter their classroom buildings. By connecting students with relevant sustainability problems on campus, the university can capture the imagination and interest of students both inside and outside of the classroom.

Using the issue of campus bird-window collisions, Temple University demonstrated the benefits of PPBL in sustainability education by engaging students from across disciplines to study a specific problem, develop solutions and take leadership roles to spread awareness. Through PPBL initiatives, students discovered that the most collision prone buildings on Temple's campus are those constructed with large expanses of glass, have highly reflective or transparent glass and have vegetation situated close to buildings that cause habitat reflections. Students also found that inexpensive strategies, such as the application of window film and window netting, are successful at mitigating bird collisions. Research, curricular and co-curricular opportunities enabled students to gain a deeper understanding of the bird-window collision issue and help build core sustainability competencies.

As the university continues to identify site-specific, strike mitigation tools that are effective, financially feasible and aesthetically pleasing, projects implemented as part of this PPBL case study resulted in tangible action. Examples of this include the installation of window film at two collision-prone buildings after the success of the "Bird's Eye View" project and the inclusion of bird-friendly design guidelines into Temple's green building policy.

In addition, one important study limitation can be utilized to create another learning opportunity. While clear patterns and problems were documented through bird strike monitoring efforts, the data was collected in a non-scientific method. Earlier monitoring efforts included collection of dates and locations. Later efforts also included times, species and specimen conditions. Development of a standardized collection tool and protocol is recommended to ensure data accuracy and consistency (Loss et al. 2014a).

While this case study demonstrated the benefits of PPBL, projects initiated to address the campus bird-window collision issue generally occurred in an ad hoc manner through separate campus initiatives. Temple's use of PPBL was inherently interdisciplinary through the engagement of different departments and organizations. The PPBL process could be improved by identifying learning objectives up

front and bringing faculty, thought leaders and external partners together for a transdisciplinary experience.

It is recommended that the university continue to utilize the campus as a tool for student exploration of sustainability through PPBL opportunities. The success of the bird-window collision study could be used as a framework for other campus sustainability issues. To further ascertain the effectiveness of PPBL techniques, it is recommended that the university develop an assessment tool to determine whether the knowledge of sustainability gained during such projects extends beyond the specific problem focus.

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Authors Biography

Katherine Switala Elmhurst joined the Office of Sustainability in August 2009 while pursuing her Ph.D. in engineering from Temple University. As the Program Manager, she is responsible for supporting the LEED certification process for campus buildings, leading sustainability-related student research and interdisciplinary collaboration and preparing Temple University's annual Greenhouse Gas Inventory. Prior to joining the Office of Sustainability, Katherine worked for nearly ten years as a project manager for an architectural, engineering and planning firm specializing in historic building preservation. She received her B.S. degree in Building Science and

Construction from Auburn University, her M.S. degree in Civil Engineering from the University of Colorado and her Ph.D. in Civil Engineering from Temple University. She is a LEED Accredited Professional.

Kathleen Grady leads the Office of Sustainability in implementing the university's Climate Action Plan. As the Director of Sustainability, she is responsible for developing partnerships within the university to advance sustainability on campus in the areas of transportation, energy conservation, energy efficiency, recycling, waste minimization and water conservation. She also works with faculty, staff and students to foster a sustainable culture on campus via curricular and co-curricular activities. Prior to joining the Office of Sustainability, Kathleen worked for five years in the private sector in a planning, architecture and landscape architecture firm as a municipal planner, developing sustainable master plan elements and affordable housing plans. She received a bachelor's degree in Political Science from American University and also earned a Masters in City and Regional Planning and a Masters in Social Work from the University of Pennsylvania. She is an AICP certified planner and a LEED Accredited Professional.

Multimedia Exhibition Teaches Undergraduate Students About Sustainable Fashion

Britanny E. Reef-Stout and Katalin Medvedev

Abstract

Fashion industry leaders and academic scholars have indicated that there is a great need in higher education to teach fashion students about sustainable fashion because fashion students simultaneously represent a group of fashion consumers and future industry professionals. The limited research published on this topic has concluded that there are significant gaps in fashion students' knowledge of sustainable fashion, which creates a fundamental need for finding ways to effectively educate fashion students about sustainability. Students currently enrolled in higher education represent the "Millennial Generation." Previous research has indicated that Millennials learn best when they are able to connect abstract concepts with concrete examples, using experiential learning techniques. In light of this, the purpose of this study was to test the validity of such research findings by examining the effect that experiential learning, utilizing multimedia learning tools, has on fashion students' knowledge of sustainability in fashion manufacturing. The experiential learning activity was an educational exhibit titled Fashion & Sustainability. The exhibit provided students with an opportunity to *experience* social, environmental, and economic sustainability related to the fashion industry in a learning space specifically designed to exemplify the various facets of sustainable fashion through the utilization of multimedia learning tools, including visuals, video, and hands-on activities. To better understand the effect that the experiential techniques had on students' learning, the study measured the learning outcomes between two groups of undergraduate students enrolled in fashion courses in the Department of Textiles, Merchandising, and Interiors at The University of Georgia. Survey questionnaires were used to measure students' learning and were quantitatively

B.E. Reef-Stout (✉) · K. Medvedev
Department of Textiles, Merchandising and Interiors, University of Georgia,
305 Sanford Drive, Athens, GA 30602, USA
e-mail: britanny.reef@gmail.com

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and qualitatively analyzed using t-tests and theme identification. The first group included students that were enrolled in an introductory fashion course, TXMI 3210, which covered the basic principles of sustainable fashion. The second group of students only attended the exhibition and learned about sustainable fashion through the exhibit alone. Ultimately, there was minimal difference between the acquired knowledge of students that participated in the course and attended the exhibition, compared to the students that only attended the exhibition, which suggests that through experiential learning methods, students are able to learn just as much, if not more, about sustainable fashion.

Keywords
Fashion · Sustainable development · Higher education · Experiential learning

1 Introduction

Fashion industry leaders and academic scholars have indicated that there is a great need in higher education to teach fashion students about sustainable fashion because fashion students simultaneously represent a group of fashion consumers and future industry professionals (Gwilt and Rissanen 2011; Hethorn and Ulasewicz 2008; Leerberg et al. 2010). Despite this need, in the United States, higher education apparel and textile programs continue to have a "free-choice" option whether to include sustainability into their fashion curricula. The limited research published on the topic has concluded that there are significant gaps in fashion students' knowledge of sustainable fashion (Bostic 2008; Ha-Brookshire and Norum 2011). This lack of knowledge among students creates a fundamental need for finding ways to effectively educate fashion students about sustainability in a way that will aid students as fashion consumers and future fashion professionals (Dobson 2007). Therefore, the objective of this experimental study was to examine the effect that experiential learning, utilizing multimedia learning tools, has on fashion students' knowledge of sustainable fashion.

The fashion industry has yet to come up with a universally accepted definition of sustainable fashion and exact specifications for what makes fashion goods sustainable. In this study, sustainable fashion was placed within the United Nations' framework for sustainable development (WCED 1987), and within the framework of the 7-stage fashion product life cycle—research, design, manufacturing, merchandising, retail, consumer use, and post-consumer disposal (Indiana University 2015). Based on several sustainable development perspectives, sustainable fashion was defined as fashion goods that meet the needs of current generations and embody conscious actions towards environmental protection, social responsibility, and economic development within each of the seven stages of the fashion product

life cycle, so as not to compromise the ability of future generations to meet their own needs.

The study was grounded in a constructivist paradigm (eds Dills and Romiszowski 1997) and guided by Kolb's (1984) Experiential Learning Theory as well as Mayer's (2001) Cognitive Theory of Multimedia Learning. Kolb's (1984) theory proposes that learners progress through a continuous learning cycle of concrete experience, reflective observation, abstract conceptualization, and active experimentation. Mayer's (2001) Cognitive Theory for Multimedia Learning states that students learn best when visuals and text are used together to explain particular phenomena. "Visuals" include illustrations, photos, animations, and video; and "text" refers to speech and printed text (Mayer 2009). Mayer's (2009) research concludes that multimedia learning is effective because "more material can be presented on two channels than on one," and "understanding occurs when learners are able to build meaningful connections between pictorial and verbal representations" (p. 7). Because Millennial students, which includes the current generation of fashion students, prefer learning environments that support the use of technology and media (Brown et al. 2011), it was imperative to integrate multimedia learning tools into the design of this study that investigated the effectiveness of experiential learning to increase students' knowledge of sustainable fashion.

2 Literature Review

Sustainable fashion was first introduced into higher education in the United States by integrating principles of sustainability into fashion courses through readings, lectures, and student projects (Ha-Brookshire 2008; Su et al. 2012). More recently, fashion programs have begun to redesign their curricula to include an emphasis on sustainable fashion (Landgren and Pasricha 2011; Leerberg et al. 2010; Pasricha and Kadolph 2009). Fashion courses founded upon sustainable principles represent the ideal, and quite possibly the future design of all higher education fashion-related programs in the United States (Leerberg et al. 2010).

Despite attempts in higher education to teach principles of sustainability in apparel and textiles programs, research highlights significant gaps in fashion students' knowledge of sustainable fashion. Specifically, Ha-Brookshire and Norum's (2011) research found that students were unable to identify principles of "organizational responsibility," which means that they did not understand what fashion businesses actually do to become sustainable. Students were also unable to clearly identify what the concepts of "sustainable development" and "personal responsibility" meant and how they were associated with the production and consumption of fashion goods (Ha-Brookshire and Norum 2011). Bostic's (2008) research on students' knowledge of sustainable fashion found that although students possess a general understanding of sustainable fashion (i.e. awareness of the primary issues) they lack detailed knowledge on concepts of sustainable fashion. Therefore, Bostic's (2008) study suggested that higher education fashion courses needed to put

greater emphasis on the meaning of sustainability concepts and how they relate to the fashion industry.

Institutions of higher education in the United States generally use the lecture method of teaching. While this method can be easily implemented, standard lecturing, or what Fink (2003) refers to as "passive learning," it has many limitations on student learning outcomes. Therefore, Fink has concluded that changing or altering the style of teaching in higher education will have positive outcomes on student learning.

Another problematic aspect of standard lecture classes is that students are only provided with a theoretical view of sustainable fashion through reading about it in their textbooks. However, the fashion product life cycle is a complex, multifaceted, global process that involves a multitude of industry stakeholders and practices (Kunz and Garner 2007). Sustainable fashion also encompasses the social, environmental, and economic responsibilities of the fashion industry within each of the seven stages of the fashion product life cycle. Despite this, in most fashion programs, students get exposed only to a portion of the fashion product life cycle. Therefore, in order to engrain the concept of sustainable fashion into the minds of students, it is imperative that professors not only link together theory and practical application, but present them to students through concrete examples as well. In addition, instead of merely supplementing their topic-based courses, like textiles or product development, with sustainable fashion principles, educators should consider restructuring their curriculum so that students are exposed to all facets of sustainable fashion (Su et al. 2012).

The United Nations set up the Education for Sustainable Development (ESD) program to increase global educational efforts that "integrate the principles, values, and practices of sustainable development into all aspects of education and learning" (UNESCO 2012). Influenced by their mission, this study utilized ESD's "modeling reality" teaching technique which transfers knowledge of a subject matter to students through experience-based learning activities (Fink 2003). Fink (2003) classifies "modeling reality" as an active learning strategy, in which knowledge of a subject matter is transferred to students through experience-based activities. Students either "do" or "observe" the phenomena they study, and then reflect on their experience, which is a critical component of active learning strategies (Fink 2003). "Doing" experiences require students to apply particular skills and knowledge to accomplish a task. Through "observing" experiences, students gain knowledge and/or acquire a particular skill set by either watching or listening to instruction (Fink 2003).

Students currently enrolled in higher education represent the "Millennial Generation," also known as the first generation of the "information age" (Brown et al. 2011). The significant weight that technology and media play in Millennials' academic and personal lives presents a new set of challenges and opportunities for learning (Brown et al. 2011; Pasricha and Kadolph 2009). The traditional communication channels that are commonly utilized in higher education, such as reading and writing, are challenging for Millennials because this generation prefers active engagement, student-centered learning activities, and extensive utilization of

multimedia in their learning environment (Brown et al. 2011; Pardue and Morgan 2008). In order to effectively communicate and engage Millennial students, higher education needs to integrate experiential and hands-on activities, team-based learning, and multimedia learning tools into courses, in addition to theories and abstract concepts (Brown et al. 2011).

Millennial students hold significantly different preferences for their learning environment than prior generations. In fact, research has concluded that traditional classroom lectures are the least effective pedagogical strategy for Millennials (Brown et al. 2011; Nicoletti and Merriam 2007; Sweeney 2006). Millennial students are used to multitasking and thus find it difficult to concentrate on just one topic or activity at a time, such as a classroom lecture (Brown et al. 2011). This generation is also challenged by the overload of information available to them through various technologies and the media, such as the internet, television, magazines, and newspapers (Brown et al. 2011). Consequently, Millennial students must learn to develop superior critical thinking skills to be able to clearly identify valid data (Brown et al. 2011; Pardue and Morgan 2008).

3 Methods

The purpose of the study was to examine the effect that experiential learning, utilizing multimedia learning tools, has on fashion students' knowledge of sustainability in fashion manufacturing. The study was designed to measure the different learning outcomes between two groups of undergraduate students enrolled in fashion courses in the Department of Textiles, Merchandising, and Interiors at The University of Georgia. The same data was collected using survey questionnaires from both groups of students before and after they viewed the Fashion and Sustainability exhibit. The first group included all students enrolled in TXMI 3210 Fundamentals of Fashion Merchandising with Emphasis on Sustainability in the Fashion Industry. This group read Timmerman's (2012) *Where am I wearing?: A global tour to the countries, factories, and people that make our clothes* and participated in a standard lecture course where they learned about sustainable fashion in lectures and group discussions. Timmerman's book was chosen because it provides students with an introduction to global trade and economics in the fashion industry and highlights social injustices that are prevalent in fashion manufacturing, such as various forms of labor exploitation. The second group of students only attended the exhibition without any prior training or formal education on sustainable fashion.

3.1 The Rationale for the Experiential Learning Activity

An educational exhibition was chosen as the experiential learning activity because it provided students with an opportunity to *experience* environmental, social, and economic sustainability related to the fashion industry in a learning space that was

specifically designed to exemplify sustainable fashion through the utilization of multimedia learning tools. The design and layout of the Fashion & Sustainability exhibit was based on two structural frameworks. The first framework was the 7-stage fashion product life cycle—research, design, manufacturing, merchandising, retail unit, consumer use, and post-consumer disposal. Among these, the exhibit placed the greatest emphasis on fashion manufacturing because there is a large disconnect between foreign producers and American consumers, mostly because very few fashion items are produced domestically (ed. Hoffman 2007; Timmerman 2012).

The second framework of the exhibit showcased the United Nations' (2005) "three pillars" of sustainable development—social development, economic development, and environmental protection—within each stage of the fashion product life cycle. The purpose of this structural framework was to increase fashion students' foundational knowledge of the fashion product life cycle from a sustainable perspective. This portion of the exhibit provided students with basic information on sustainability related to the fashion industry and included the presentation of both sustainable issues and solutions.

Sustainability topics were determined based on a set of learning goals that were generated using Fink's (2003) taxonomy and existing scholarly research. Specifically, the research by Wiek et al. (2011) on the five key competencies that need to be mastered when addressing sustainable development was used to determine topics of sustainability that were broad enough to span the entire fashion product life cycle. The exhibit presented information collected from previous scholarly research, industry data, government agencies, professional organizations, and the news. Resources, from the *Journal of Textile & Apparel Technology & Management*, *Fashion Practice*, and from websites of The World Bank, UNESCO, Ethical Fashion Forum, Ecotourre, Fairtrade International, International Labour Organization (ILO), and *The New York Times* were also utilized in the form of text, visuals, graphics, and video/animations, in addition to artifacts.

3.2 Participants and Their Involvement in the Active Learning Experiment

A total of 107 (n = 107) undergraduate students enrolled in fashion merchandising and interior design courses in the Department of Textiles, Merchandising, and Interiors at the University of Georgia participated in the study with approximately equal representation between students that were enrolled in the TXMI 3210 course (51 %) and students that were not enrolled in the course (49 %). Among the participants, 92 % were female, 4 % were male, and 4 % did not disclose their gender. Students were primarily Fashion Merchandising (42 %), Interior Design (16 %), and Marketing/Advertising (16 %) majors. There was a mix of freshmen (5 %), sophomores (31 %), juniors (45 %), and seniors (15 %).

Upon arrival at the Fashion & Sustainability exhibit, students first watched *The True Cost: The Future is On Sale* (Ross and Morgan 2013) documentary trailer as

an introduction to Western commercialism, which is especially pertinent to the fashion industry as commercialism adds to the industry's environmental, social and economic destruction (Hethorn and Ulasewicz 2008; ed. Hoffman 2007). After the video, students walked through each stage of the fashion product life cycle, while the primary research investigator acted as a tour guide to provide them with additional explanations and address any questions or comments. To make students think critically and creatively about sustainability in the fashion industry, they were also provided with a brief, educational handout before the tour started. The handout included additional industry information and facts, and provided students with discussion questions that prompted them to reflect on their dual role as fashion consumers and future industry professionals.

3.3 Research Question and Data Collection Methods

Due to the nature of the theoretical frameworks and the philosophical assumptions made about the process of students' construction of knowledge, the study used a mixed methodological approach to collect data to answer the research question: What effect does experiential learning, utilizing multimedia learning tools, have on fashion students' knowledge of sustainable fashion? Data on fashion students' knowledge of sustainable fashion was collected using pre-and-post-exhibit survey questionnaires. The survey questionnaires included modified questions from previous research that surveyed students' knowledge of sustainable fashion (Bostic 2008; Ha-Brookshire and Norum 2011), as well as questions designed specifically for this research study. In addition to asking students about their knowledge of sustainable fashion, the post-exhibit survey questionnaire also included a section that asked students about their educational learning experience at the exhibition.

The knowledge section of the survey questionnaire measured fashion students' awareness and understanding of environmental, social, and economic sustainability related to the fashion industry. Students' knowledge was quantitatively measured using 16 items that asked students to identify on a five-point Likert scale (1 = Strongly Disagree; 5 = Strongly Agree) their perceived level of knowledge on sustainability in the fashion industry. In addition, students were asked to identify the best definition for "eco-friendly," "socially-responsible," and "fair trade" fashion from a list of multiple-choice answers. The knowledge section also assessed students' knowledge qualitatively. Five open-ended questions were used to ask students to explain in detail what they know about environmental, social, and economic sustainability as it pertains to the fashion industry. The open-ended questions were designed to allow students to expand on their close-ended responses.

The educational learning experience section of the post-exhibit survey questionnaire measured how students' perception of the exhibit and the how effective they thought the use of multimedia learning tools was to their learning about sustainable fashion. This section included 9 close-ended questions that asked students to identify on a five-point Likert scale (1 = Strongly Disagree; 5 = Strongly

Agree) their assessment of the multimedia educational learning tools used in the exhibit. This section also included an open-ended question that asked students to explain which portion(s) of the learning experience was the most beneficial to their learning about sustainable fashion.

The quantitative and qualitative data from the pre-and-post survey questionnaires were analyzed using mixed methods. The quantitative data was statistically analyzed using t-tests to identify any significant changes between students' responses to close-ended questions before and after the exhibit (Cramer 2000). The qualitative data was used in support of the quantitative data and analyzed students' responses to open-ended questions using theme identification (Maxwell 2012) to identify their central ideas and understanding of sustainable fashion.

3.4 Limitations

There were some limitations to the study. First, the sample population of the study was relatively small and included fashion students from only one institution of higher education. Additionally, fashion courses at The University of Georgia do not significantly address topics that pertain to sustainability. Therefore, the results of this study might vary if students in the sample population were enrolled in universities where sustainability is more widely addressed. Second, while the exhibit was designed to provide students with pertinent information on environmental, social, and economic sustainability in the fashion industry, not all information on sustainability could be covered in a single educational experience. The results of this study might have varied if students had been provided with more information on sustainable fashion. Lastly, the post-exhibit survey questionnaires were collected one week following students viewing of the exhibition. The results might have varied had the study been designed to measure the longevity of students' acquired knowledge about sustainable fashion.

4 Results and Discussion

4.1 Knowledge of Sustainable Fashion

Students were more knowledgeable about sustainable fashion, as it relates to the entire fashion product life cycle, after they viewed the Fashion & Sustainability exhibition. Prior to the exhibition, students' definitions of sustainable fashion weighed heavily towards concepts and ideas related to environmental sustainability, using sustainability buzzwords, such as "environmentally smart" and "green" to define sustainable fashion (See Table 1). At the exhibit though, students were encouraged to think critically about sustainable fashion production and consumption, and the responsibility of key stakeholders in the work towards creating a more sustainable fashion industry. After the exhibition, students defined sustainable

fashion in a holistic manner, and addressed the importance of all three components of sustainable fashion—environmental protection, and social responsibility, and economic development—within each of the seven stages of the fashion product lifecycle.

4.2 Knowledge of Environmental Protection in Fashion Manufacturing

Students' comprehension of environmental issues related to fashion manufacturing expanded after the exhibition (See Table 2). Before the exhibit, students exemplified that they had a general understanding of environmental issues by listing overarching terms, such as "pollution," but were not able to provide specific details. In contrast, after the exhibit, they were able to explain environmental issues in more detail and no longer used umbrella terms, like "pollution," but discussed specific types of pollution, such as air and water pollution. This finding is similar to Bostic's (2008) research that found that students possess a general understanding of sustainable fashion, but lack detailed knowledge of sustainable fashion concepts. Based on students' post-exhibit survey data, the exhibition was successful in increasing students' knowledge of principles and concepts related to environmentally sustainable fashion.

After the exhibition, students were also able to restate environmental facts, and reference particular exhibition displays to support their answers. For example, there was a tower of water bottles at the exhibition to display the vast amount of water consumed during the garment dyeing process (See Fig. 1). This display, in particular, prompted students to write more detailed answers on the post-exhibit survey about the number of gallons of water needed to manufacture individual apparel items, such as jeans and t-shirts. This finding supports the Multimedia Principle in Mayer's (2001) Cognitive Theory for Multimedia Learning that states that students learn best when visuals and text are used together to explain particular phenomena. In the case of the exhibition, students' increased comprehension of environmental issues in fashion manufacturing was a direct result of their learning about these issues through various multimedia tools, such as text, videos, pictures, and artifacts.

Students also made connections between environmental exploitation and its effects on humans after the exhibit when they discussed the significant implications that air, water, and land pollution can have on local communities. For example, one student modified her answer from using only one word, "dyes," on the pre-exhibit survey to "dyes from clothing in the rivers/lakes make children sick" on the

Table 1 Students' definitions for sustainable fashion

Pre-exhibit survey	Responses	Post-exhibit survey	Responses
Environmental protection	85	Environmental protection	95
Social responsibility	56	Social responsibility	82
Economic development	42	Economic development	69

Table 2 Students' knowledge of environmental issues in fashion manufacturing

Pre-exhibit survey	Responses	Post-exhibit survey	Responses
Waste	33	Water	90
Pollution	31	Waste	72
Chemicals	30	Chemicals	52
Water	29	Air	45
Animals/Fur	17	Pollution	31
Air	14	Land/Soil	21

Fig. 1 Water use in fashion manufacturing

post-exhibit survey. The displays at the exhibition were specifically designed to visually convey how environmental, social, and economic issues in fashion manufacturing are not isolated problems, but rather each component either positively or negatively affects the others. Overall, students' post-exhibit survey responses reflected an increased understanding of the interrelatedness of social, economic, and environmental issues.

Students were less concerned with animal rights after they viewed the exhibition than expected. We speculate that it was because only one poster explained the use of animals in fashion manufacturing. The poster was small in size in comparison to the other environmental displays, and included mostly text and silhouette drawings,

instead of actual pictures. The lack of realistic illustrations could have directed students' focus away from the use of animals to make fur and leather products towards other environmental issues that were displayed through more lifelike visuals. This suggests that in order to effectively teach Millennial students about sustainability, educators must (a) individually emphasize a particular subject matter to focus students' learning, and (b) present facts about sustainability in a realistic and visual manner by using pictures and videos that depict real events.

4.3 Knowledge of Social Responsibility in Fashion Manufacturing

Students came away with a more profound understanding of social issues in fashion manufacturing after the exhibition. For example, on the post-exhibit survey they described in detail the harsh working conditions in some garment and textile factories. They noted the psychological and physical mistreatment of garment and textile workers, and emphasized the lack of basic human and workers' rights, all of which had been covered by the umbrella term "sweatshop" on the pre-exhibit survey (See Table 3). It seems that before the exhibition, students instinctively used the word "sweatshops," but did not fully comprehend what it meant or what practices occur in sweatshop-like factories.

After the exhibition, students explained that because the pictures and videos of garment and textile factories at the exhibit presented a lifelike representation of the social issues in fashion manufacturing, they felt as if they *experienced* the same burdens and hardships suffered by garment workers on the other side of the world. Therefore, they were better able to describe the social confines of sweatshop-like factories and the plight of poverty of garment workers in developing countries. This finding supports Vygotsky's (1987) claim that students do not learn concepts by simply memorizing or reiterating words, but that students need to be able to bridge their everyday understanding with abstract concepts. Students understood prior to the exhibition what social, mental, and physical abuse was; however, through visual learning at the exhibition they realized that "sweatshops" involved such abuses.

Students also thought critically about the causes of social issues in fashion manufacturing after the exhibition. One display in particular highlighted the tragic Rana Plaza building collapse in Savar, Bangladesh in 2013 and used photographs,

Table 3 Students' knowledge of social issues in fashion manufacturing

Pre-exhibit survey	Responses	Post-exhibit Survey	Responses
Sweatshops	50	Working conditions	75
Child labor	31	Treatment of laborers	58
Human rights and labor rights	27	Manufacturers' wages	56
Working conditions	24	Human rights and labor rights	50
Manufacturers' wages	20	Child labor	48
Fur/Animals	10	Sweatshops	41

text, and video to show the deadly effects of the collapse on the garment workers trapped beneath the rubbles, as well as family members that mourned the loss of their loved ones (See Fig. 2). Although students said during the exhibit tours that they were aware of the event at Rana Plaza, to them it was just another misfortune that occurred somewhere else in the world and was briefly reported in the news. Students viewed the situation as someone *else's* problem and did not see how it personally affected them as fashion consumers or future fashion professionals. However, when students were confronted with images of the Rana Plaza tragedy at the exhibition, which forced them to pause and think about it, they were able to critically evaluate the situation and identify that faulty building construction and lack of basic safety standards caused the tragedy. Furthermore, students examined their connection to the victims of Rana Plaza as they reflected on their dual role as fashion consumers and future industry professionals, and stated that they felt personal responsibility for creating a more socially responsible fashion industry.

4.4 Knowledge of Economic Development in Fashion Manufacturing

Students were the least knowledgeable about economic issues in fashion manufacturing before and, unfortunately, after the exhibition as well. In fact, the economic issues that students listed were the most diverse in comparison to their lists of environmental and social issues. The breadth of students' answers included more

Fig. 2 Rana Plaza factory collapse

than 30 categories, and the most common answers only reached 41 responses on the pre-exhibit survey and 57 responses on the post-exhibit survey out of a total of 107 student responses (See Table 4). This suggests a significant need in higher education to highlight the economic principles related to sustainability and devote time to discussions on how the fashion industry influences the global economy.

4.5 Quantitative Analysis

Students' quantitative data supported the qualitative data and revealed an increase in their understanding of environmental protection, $t(107) = 11.06$, $p < 0.001$; social responsibility, $t(107) = 13.05$, $p < 0.001$; and economic development, $t(107) = 14.06$, $p < 0.001$, related to fashion manufacturing after the exhibition. There was a significant increase in students' understanding of how the fashion industry promotes environmental protection, $t(107) = 14.31$, $p < 0.001$; social responsibility; $t(107) = 11.46$, $p < 0.001$; and economic development, $t(107) = 12.43$, $p < 0.001$. Overall, the data suggests that the Fashion & Sustainability exhibition was a successful learning experience to teach students about sustainable fashion manufacturing.

4.6 Learning Experience

In order to better understand the impact that the Fashion & Sustainability exhibition had on students' knowledge of sustainable fashion, students were asked to rate their learning experience at the exhibition on a 5-point Likert scale (1 = strongly disagree; 5 = strongly agree). Because the learning experience questions were only asked on the post-exhibit survey, the average score of each question was measured and the results pertaining to the various exhibit formats are listed in Table 5. Students also answered one open-ended question that asked them to compare their learning experience at the exhibit with their typical learning experience in a traditional classroom.

Overall, both groups of students that participated in the study favored the exhibition over a traditional classroom experience. Only one student, who was enrolled in TXMI 3210, reported on the post-exhibit survey that she would have preferred a lecture to the exhibition because she felt she learned best through a traditional lecture format. In contrast, many students from both groups reported that

Table 4 Students' knowledge of economic issues in fashion manufacturing

Pre-exhibit survey	Responses	Post-exhibit survey	Responses
Outsourcing production	41	Low wages	57
Low wages	36	High prices and retail mark-up	27
High prices and retail mark-up	23	Outsourcing production	25
Working Conditions	15	Fair Trade	23

the most beneficial aspect of the exhibit was the fact that they could learn at their own pace, and also felt that the exhibition created a non-threatening learning environment where they could learn as they liked rather than being forced to memorize information.

The visuals at the exhibition were the most compelling of all the multimedia tools used to aid students' learning about sustainable fashion (See Table 5). Many students explained that they were visual learners and that the use of photographs helped them to pinpoint the most critical sustainability issues in fashion manufacturing, as well as understand the gravity of the situation for the apparel industry as a whole. Similarly, many students also thought that hands-on activities and interaction with the exhibit displays were beneficial to their learning. For example, students mentioned that it was fun to try the sewing activity, which provided them with the opportunity to try to sew a piece of fabric in the same amount of time that a garment worker is given for the same task. Students also enjoyed the zero-waste activity, which challenged them to put the pieces of an entire yard of fabric back together like a puzzle. Students stated that such activities made learning more interesting and helped them to better relate to what they were learning.

4.7 TXMI 3210 Versus Non-TXMI 3210 Students' Knowledge

While it was originally thought that the Fashion & Sustainability exhibition would have a greater influence on TXMI 3210 students' knowledge because they learned about sustainable fashion for an entire semester and had acquired a basic knowledge of sustainability concepts, the data revealed a different outcome. The quantitative data shows that TXMI 3210 students' knowledge of sustainability related to fashion increased at the same rate as that of students *not* enrolled in the course. The qualitative data also reflected that for the most part TXMI 3210 students did not always learn more about sustainability than their peers that simply participated in the exhibition.

There was only marginal difference between the two groups of students' knowledge of sustainable fashion as it relates to the entire fashion product lifecycle. Both groups stated on the pre-exhibit survey that sustainable fashion included environmentally sustainable practices, and they both acknowledged that social and economic sustainability also play a key role in sustainable fashion on the

Table 5 Learning experience

Survey question: The use of _____ in the exhibit helped to increase my understanding of sustainability in fashion manufacturing.	Average score
Visuals	4.82
Written Text	4.48
Videos/Animation	4.63
Hands-on Activities	4.60

Measured on a 5-Point Likert Scale

post-exhibit survey, which suggests that both groups of students began with comparable knowledge. Either throughout the TXMI 3210 course, augmented with the knowledge gained at the exhibit, or by participating in the exhibition alone, both groups of students were able to come to the same conclusion that sustainable fashion includes the practice of environmental, social, and economic sustainability at every stage of the fashion product life cycle.

There was no measurable difference between the two groups' abilities to identify the best definition for "eco-friendly," "socially-responsible," and "fair trade" fashion. However, after students viewed the exhibit there was a significant increase in both groups of students' understanding of environmental, social, and economic sustainability related to fashion manufacturing, and in their understanding of how the fashion industry promotes environmental, social, and economic sustainability in fashion manufacturing. Consequently, both groups self-reported higher levels of understanding of environmental, social, and economic sustainability on the post-exhibit survey. This also explains why there was statistically little difference between the groups. Based on the survey data, it can be concluded that the Fashion & Sustainability educational experience did not have a significantly greater influence on TXMI 3210 fashion students' knowledge of environmental, social, and economic sustainability related to the fashion industry than on students not enrolled in the course.

5 Conclusion

The findings from this study suggest that in order to successfully teach students about sustainable fashion manufacturing, educators should be encouraged to incorporate experiential learning into their curriculum, which includes the use of visuals, videos, and hands-on activities. Students that participated in the study had a general knowledge of sustainable fashion prior to visiting the exhibition; however, their level of knowledge on the topic expanded greatly after they learned about the multiple facets of sustainable fashion—social, environmental, and economic sustainability—which they attributed to the use of multimedia learning tools that were used throughout the exhibition.

The majority of students in the study had felt no connection to the garment and textile workers that manufacture their fashion goods before the exhibition. Therefore, they were not able to adequately identify and describe social issues in fashion manufacturing, although they did mention that "sweatshops" and "working conditions" were a problem. However, at the exhibit, students *experienced* the daily lives of these workers through visuals, videos, and hands-on activities. As a result, students became aware of the struggles that garment workers face and were able to describe in greater detail the issues involved in fashion manufacturing as well as identify practical solutions for improvement. Students also acknowledged their responsibility as fashion consumers and future fashion professionals in creating a more sustainable fashion industry. This suggests that in a traditional classroom,

fashion educators would benefit from incorporating more visuals of fashion manufacturing into lectures, together with hands-on activities that encourage students to imagine the daily life of garment and textile workers. In addition, educators should encourage students to reflect on their dual role as fashion consumers and future professionals to help students understand their social, environmental, and economic responsibility in the fashion industry.

It is also important that in higher education students are taught environmental, social, and economic sustainability as separate components. At the same time, it has to be made clear to them that the three components are interconnected. At the exhibition, students were able to tour rooms that showcased environmental, social, and economic sustainability in fashion manufacturing separately. On the post-exhibit survey they reported that this helped them to visually compartmentalize the three different pillars of sustainability. The displays at the exhibition also interlinked the three components and explained how each can either positively or negatively affect the others. Therefore, students were able to see that the manufacturing of truly sustainable fashion goods takes into consideration the environment, society, and economy at every stage of the fashion product life cycle. In light of this, we recommend that in a traditional course on sustainable fashion, the semester is divided into three components and emphasizes each component—environmental protection, social responsibility, and economic development as separate units while also helping students bridge each component as they relate to the entire fashion product life cycle.

The study measured the different learning outcomes between two groups of students. The first group of students participated in a traditional lecture course that taught basic sustainability concepts related to fashion manufacturing. This group also visited the Fashion & Sustainability exhibition. The second group only viewed the exhibition. The data collected from both groups of students revealed that there was no measurable difference between the knowledge that each group of students had after viewing the exhibition. In fact, students that only visited the exhibition demonstrated the same level of knowledge as students that participated in a semester-long course. This finding suggests that the exhibition, which utilized multimedia learning tools to teach fashion students about sustainable fashion manufacturing was just as, if not more effective, than a traditional lecture course.

5.1 Future Studies

This study presented new research on the usefulness of an educational exhibition that utilizes multimedia learning tools to teach fashion students about sustainable fashion. It is recommended that future studies replicate the exhibition with an emphasis on fashion manufacturing, but with a different sample population to see if the results of the study vary between different groups of fashion students. It is likely that fashion students' knowledge, attitudes, and behaviors will differ based on geographical location. However, if Millennial students truly learn best when

multimedia tools are incorporated into their learning, as our results strongly suggest, the results of future studies should be consistent with the findings of this study.

The Fashion & Sustainability exhibition emphasized only one of the seven stages of the fashion product life cycle—fashion manufacturing—and only briefly covered environmental, social, and economic sustainability in the other six stages—research, design, merchandising, retail unit, consumer use, and post-consumer disposal. It is recommended that future studies experiment with the other stages of the fashion product life cycle to see if the results are consistent with the findings of this study. It is also advised to limit future exhibitions to only one stage of the fashion product lifestyle due to students' inability to process large amounts of new information in one setting.

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Authors Biography

Britanny Reef-Stout The founder and CEO of Swenslie & Shelda, Inc, a fair trade sewing cooperative located in Lascahobas, Haiti. She received her M.S. from the University of Georgia, USA in Textiles, Merchandising and Interiors with a focus on Merchandising and International Trade. Her professional interests include sustainability in the fashion industry, education for sustainable development, fair trade apparel and textiles, and politics of international trade. Her articles have been published in *Women's Studies Quarterly* and *Clothing and Fashion: American Fashion from Head to Toe*.

Katalin Medvedev An Associate Professor in the Department of Textiles, Merchandising and Interiors at the University of Georgia, USA where she teaches courses on the cultural aspects of

dress and the fashion industry. She received her Ph.D. from the University of Minnesota in the Social, Psychological, Historical and Cultural Aspects of Dress. She is a native of Hungary and has also taught at Eötvös Loránd University in Hungary. Her professional interests focus on the construction and expression of cultural identity through dress, gender and the politics of dress, fashion and empowerment, fashion peripheries, and fashion and sustainability. Her articles have been published in *Women's Studies Quarterly, Fashion Practice, Dress, Clothing Cultures, Paideusis-Journal for Interdisciplinary and Cross Cultural Studies, International Journal of Fashion Design, Technology, and Education, International Journal of Fashion Studies, Journal of Human Sciences and Extension* as well as in book chapters published by Berg, Fairchild, Pennsylvania University Press, Purdue University Press, University of Minnesota Press, among others.

Campus Infrastructure and Sustainable Resource Management Practices: Mapping Campus DNA for Human Resiliency

Gowri Betrabet Gulwadi and Kathleen G. Scholl

Abstract

The Talloires Declaration (2015) on Sustainability, an action plan for sustainability leadership and environmental literacy, has nearly 500 signatory universities in 50 countries. Different sustainability frameworks assess practices (primarily ecological) in transportation, construction, energy, waste, food, water, and landscaping that impact university curricula, research, operations, outreach, assessment and reporting. Sustainable campuses must be conceptualized as complex nested systems with the human experience of the campus landscape at the core. Just as DNA is the language that enables resiliency of the human body system, the campus infrastructure and its sustainable resource management practices communicate and enable resiliency of everyday human experiences. Understanding the dynamic relationship between sustainable practices and core human experiences (e.g., learning and well-being) within a campus landscape helps decode the DNA of that campus and its potential for human resiliency. This paper highlights examples of interdisciplinary collaborations at a Talloires signatory university to explore links between the ecological and human dimensions of sustainability. Integrative conceptual frameworks, descriptive examples from curricular efforts, and analysis of student reflections demonstrate influences of campus ecological features on student experiences. Although challenging and complex, mapping campus DNA must include, and cannot ignore, core human experiences as universities develop future sustainable efforts.

G.B. Gulwadi (✉)
Interior Design, School of Applied Human Sciences, University of Northern Iowa, 213 Latham Hall, Cedar Falls, IA 50614-0332, USA
e-mail: betrabet@uni.edu

K.G. Scholl
Leisure, Youth and Human Services, University of Northern Iowa, 213 Wellness and Recreation Center, Cedar Falls, IA 50614-0241, USA
e-mail: kathleen.scholl@uni.edu

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Socio-ecological systems · Higher education institutions · Cross-scale relationships · Adaptive systems · Interdisciplinary · Sustainability

1 Introduction

Twenty-six years have passed since university administrators first made an official commitment to environmental sustainability actions by signing declarations such as the Talloires Declaration composed in 1990. Since then, ecological practices and campus sustainability efforts (e.g., reduction in the consumption of energy and materials) have institutionalized sustainability practices within university and college curricula, research, operations, outreach, assessment and reporting (ASSHE, n.d; Lozano 2010; Richard and Adams 2011; Shriberg 2002). However, campus sustainability endeavors have been primarily ecological focused (see Fig. 1) even though "sustainability is inherently context-dependent, and the context is multifaceted—cultural, social, political, and, most ubiquitously, spatial" (Wu 2013, p. 1023).

A university employs multiple environmental and human resources and assets that transact to meet its institutional mission and vision. While ecological capital precedes the development of human experience on campuses, human *interactions* with the campus landscape and its aesthetics become undeniably important as they relate to other environmental and economic sustainability efforts (Barrett et al. 2009a, b; Gobster et al. 2007; Keiner 2005; Shriberg 2002; Wu 2013). Therefore, human dimensions of sustainability and its many subcomponents (health and well-being, knowledge creation, and community interactions—see Fig. 2) must prominently integrate with campus sustainability master plans, construction projects, and cost reduction efforts through on-going dialogue between key university stakeholders.

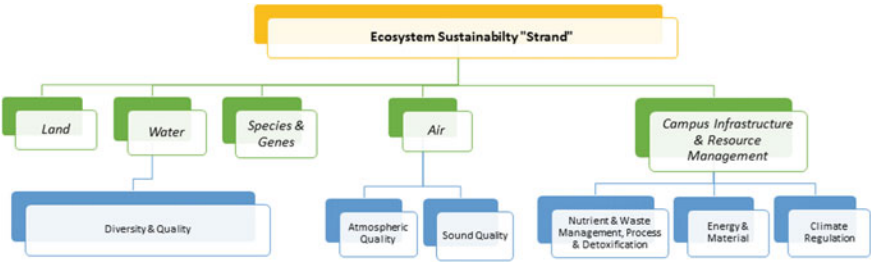

Fig. 1 Ecosystem strand of campus sustainability

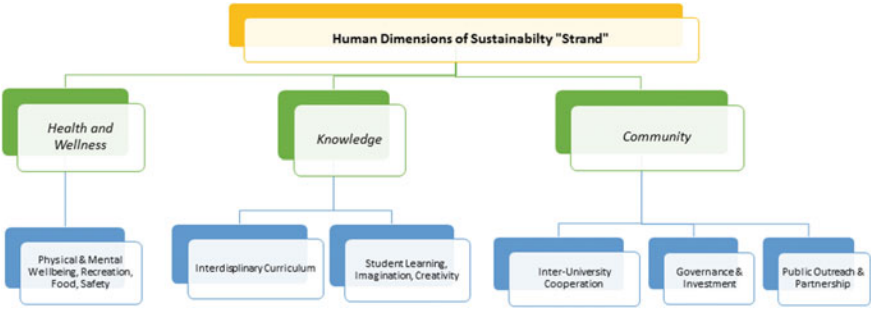

Fig. 2 Human strand of campus sustainability

Research for understanding the human dimensions of sustainability has been unexplored territory until recently (Arroyo 2015; Farina and Napoletano 2010). More importantly, little research has focused on the dynamic *cross-scale* relationship between the ecological and human dimensions of sustainability (Walker 2013). In this paper, we draw attention to both these important dimensions of sustainability as two critical "*strands*" that must link together to illustrate the dynamic and resilient nature of campus sustainability. In conceptualizing these human and ecological sustainability "*strands*" we apply the metaphor of the two biopolymer strands found in a human DNA molecule that are strung together in a double helix to carry messaging information used in the development, function, and reproduction of the human system. As Figs. 1 and 2 indicate, each of the campus sustainability strands is multidimensional. Yet, how do these dimensions interact to transmit information from one strand to the other, at what levels, through what adaptive processes, and initiated by which stakeholders to enable resilience of the campus as a system? Using the DNA metaphor, we propose that a pairing mechanism of the human-ecological system "strands" and their interaction within the context of campus sustainability is an important focus for understanding resilience. In this paper, we focus on how campuses are uniquely organized, and how the different campus entities interact and function towards human and campus resilience.

2 Unique Organizational System of U.S. Universities and Colleges

Over a 380 year history, the organizational structure and decision making process of U.S. higher education institutions (HEIs) have a unique, historical heritage compared to the characteristics of typical for-profit or nonprofit organizations. Campus-based colleges or universities employ a similar and identifiable system of operation that includes academic departments, layers of administration, support systems and an array of internal and external constituencies (Ritzen 2016; Smelser 2012). However, each university has its own intricate relations, modes of

communication and decision making processes between its units. Today's HEIs have two internal power-sharing and communication configurations: (a) *academic self-governance* and, (b) *managerial self-governance*, whereas for-profit or non-profit organizations typically function within a managerial self-governance process only. Academic self-governance supervises the curriculum and scholarship, using a peer review approach to communication and decision making using a *horizontal* self-governance primarily originating within the academic units composed of faculty. In the very early eras of HEIs, academic self-governance began as the primary communication process. Managerial self-governance supervises most other supporting campus operations using an internal communication and decision making structure - often a *pyramidal* arrangement comprised of chancellors, presidents, executive staff, deans, office directors, middle management and entry level staff, and offices of sustainability (Maes 2015; Shriberg 2002; Smelser 2012).

For nearly four centuries, due to higher education's inherent nature, HEIs have continuously incorporated auxiliary functions (which are usually but not always relevant to the university's basic function and mission of teaching, research, and service) through a process of "structural accretion" (Smelser 2012, p. 1). Examples of HEI accretions include: distance learning, public entertainment such as intercollegiate athletic events, museums, musical performances, university presses, administrative staff, adjunct instructors, temporary faculty and teaching assistants, educational programs abroad, fundraising and development offices, campaign committees, alumni relations and sponsored research offices, etc. (Smelser 2012). This accretion process is attributed to education's societal role as a social and moral institution with a publicly valued mission of institutionalizing, reproducing, and transmitting fundamental social values to future generations (Smelser 2012). This growth in university activities and structure (including campus sustainability offices) adds wings and parts to the "system." Despite the evolution of the *managerial* self-governance structure, the academic self-governance process endures as an "institutional balance of power" (Dobbins et al. 2011, p. 669).

With the size and structure of today's HEIs, it is all too common for academic and the managerial individuals to operate in their own separate spheres, under different organizational structures, and with different professional goals. As HEIs shape their responses to sustainable development (e.g., Beynaghi et al. 2015) and their sustainability efforts evolve and get embedded in the existing campus system, mapping the communication and decision making links between the academic and managerial modes of HEI self-governance is necessary. Examining nodes of communication that bridge campus sustainability efforts between the different campus units may improve our understanding of campus sustainability as an integral part of a university's function. Moreover, it will help us better understand how paired links between the human and ecological sustainability strands can be fostered for a resilient campus.

3 Sustainability Frameworks

Most sustainability frameworks offer important yet static conceptualizations of three intersecting concerns (circles, pillars, triangles) representing environmental, economic, and social resources of sustainability. Other taxonomic sustainability frameworks illustrate the mutually independent dimensions but not the dynamism and resilience-related interactions between the parts. For example, the '*MAIN prism of sustainable development*' (Kain 2000 based on Spangenburg and Bonnoit 1998) represents the relationship between *Mind, Artefact, Institution and Nature* and is useful to apply to the experience in campus landscapes. The environmental dimension (nature) comprises all natural capital (subdivided into non-renewable and renewable resources). The economic dimension (artefact) stands for all man-made material assets such as buildings and roads. The social dimension (mind) is perceived as the awareness of the individual subject (worldview, knowledge, and experience). The institutional dimension concerns the organization and the relation between people. In the '*egg of sustainability and well-being*' model, the human and the ecosystem circles nest inside one another, like the yolk of an egg (Keiner 2005). This model resembles Bronfrenbrenner's (1979) social-ecological development model where all "systems" consist of nested dynamics operating at particular organizational scales or "sub-systems." In this nested model, human sustainability and ecological sustainability are entirely dependent on the other—also suitable for understanding sustainability efforts operating within a university system. The above models best represent the complexity of the parts of the system, but do not account for the transactional complexity of the underlying adaptive processes that maintain the system and build its resilience. Therefore, we turn to the concept of resilience to help us understand not only the complex parts but the adaptive capacity of the ecological and human dimensions of the HEI campus sustainability system.

4 Resilience as a Systems Concept that Integrates Ecological and Human Dimensions of Campus Sustainability

The resiliency of any system, human or natural, in response to short-term or long-term socio-ecological change, centers on its capacity to absorb disruptions and adapt its structure—but not necessarily its function, identity and feedbacks—to a new configuration that maintains equilibrium in the system (Egeland et al. 1993; Sage et al. 2014; Walker et al. 2004; Walker and Salt 2006). A system is considered self-governing because it senses a disruption of its *thresholds*. At these critical points, known or developed *feedbacks* within the system initiate adaptive processes to move the system towards its equilibrium. For example, the human body regulates itself when it sweats or develops a fever in response to a disruption in its thermal equilibrium—higher or lower than 'normal' body temperature. The measure of a system's resilience is its distance from the thresholds (Walker and Salt 2006).

Understanding a system's components, thresholds, and feedbacks is extremely helpful in understanding the core *identity* of the system—whose equilibrium and preservation is the central goal of the adaptive processes. Additionally, systems exist at different scales (e.g., micro, meso, and macro) with adaptive processes functioning to maintain equilibrium at each scale. However, in a hierarchy of nested systems, *cross-scale processes* and feedbacks become critical players in maintaining overall identity and equilibrium. For example, the human body is composed of multiple sub-systems working concurrently on regulatory processes to maintain balance in temperature, pH, blood glucose, etc. The human body also works with a system of messengers (e.g., nerve cells) and interpreters (e.g., molecular proteins such as DNA) that convey when a threshold is breached or an adaptive process must be initiated. In this paper, we use the human body's DNA protein communication processes as a heuristic in understanding a sustainable campus. Visualizing a sustainable campus and the communication between its units as similar in complexity to an organism's DNA protein sequences and expression values might prove useful in understanding how this messaging and interpreting process works within a campus' organizational system.

To expand understanding of the cross-scale interrelatedness of the multiple components and hierarchical complexity that governs a sustainable campus' behavior in maintaining resilience, we shall refer to the term and framework '*panarchy*' (Holling et al. 2002; Walker and Salt 2006). A sustainable campus can be conceptualized as a hierarchically structured nested systems whose different scales and thresholds are connected by *spatiotemporal adaptive cycles*. These adaptive cycles yield four transient phases—birth, growth and maturation, death, and renewal—across its different scales of operation. Feedbacks can be initiated at either ends of the hierarchy—that is, large scale (macro), top down, or small scale (micro), bottom up processes. The dynamism of the system or its resilience is revealed through adaptive cycles, cross-scale linkages, and periodic adjustments to thresholds that help to manage and reduce risks to the system (Allen et al. 2014). Furthermore, how the units are linked within the system [or university] is very important. Walker and Salt (2006) conclude that "the adaptive capacity of a social-ecological system is enhanced when complex issues can be dealt with by a network of loosely connected stakeholders located at different levels of society [or university]. Such a dynamic structure allows for flexible coordination and cross-scale responses to solving problems because there is experimentation and learning going on across the network. Such experimentation, combined with the networking of knowledge, creates a diversity of experience and ideas for solving new problems. It stimulates innovation and contributes to creating feedback loops at different scales" (p. 138). These cyclical phased interactions also help reveal vulnerabilities and points of intervention for transformation of the system. Therefore, they also disclose potential for renewal and innovation. For this paper, we view the sustainable campus and its resource management practices through the theory of 'panarchy' to identify its multiple scales of functioning (e.g., administrative, academic), cross-scale linkages (e.g., ways and means of communication between the scales) and adaptive cycles (e.g. initiatives and strategies for implementation). We extend this conceptualization,

however, to propose that understanding the dynamic relationship between sustainable practices and core human experiences (e.g., learning and wellbeing) within a campus landscape helps decode the DNA of that campus.

Just as DNA repairs, restores, and maintains continuity of the human system while revealing its vulnerability for resilience and potential for innovation, we propose that unique combinations of campus components—its panarchy—help establish its DNA for human and campus resiliency. To decode the campus DNA, we must better understand the communication processes (or lack of) that occurs between its components. In this paper, we identified the two strands of the DNA to be the (a) ecological and economic sustainability strand, and the (b) human strand. Units of the ecological and economic strand include land resources, water resources, species and genes, and air (see Fig. 1). Campus management and decision making process holds these units together and makes them function well and smoothly. Units of the human sustainability strand include health and wellness, a sense of environmental aesthetics, knowledge, learning and curriculum, and a sense of community (see Fig. 2). A clear and good fit between the strands (similar to a paired sequence in human DNA) ensures smooth *cross-scale* communication, adaptive capacity (or expression), and thereby optimal human experience in an equilibrious campus (see Fig. 3).

In Fig. 3—we refer to three key enablers of resilience:

- ***nodes of communication***—key individuals within university units that are loosely linked and have the flexibility to self-organize.
- ***paths of communication that include resources***—passive or active; tight or loose information exchange through intermediaries.
- ***resource and management decisions***—past, present, and future sustainability efforts.

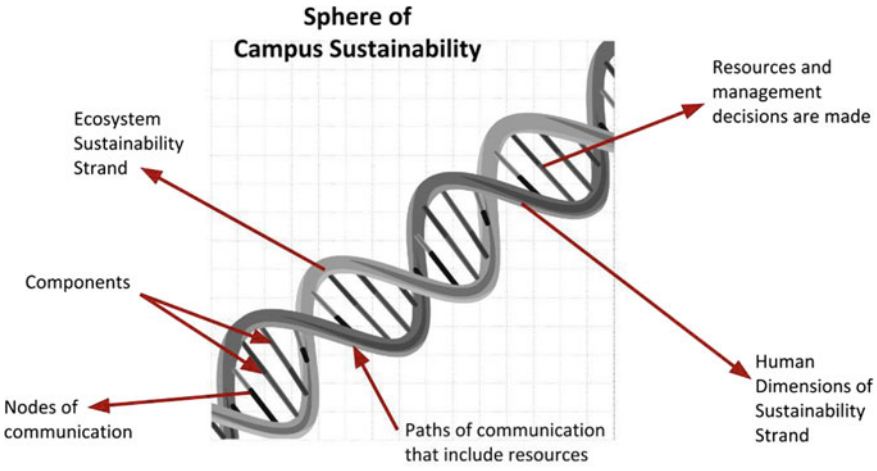

Fig. 3 Campus DNA sustainability infrastructure

Thus far, we have applied our understanding of the human body system and resiliency in self-governing systems to the working of a sustainable campus through the above model. We propose that mapping campus DNA, especially its transactions between the human and the environment strands is a useful step in revealing the potential resiliency of a campus. As universities develop future sustainable efforts, such an exercise must also include, and cannot ignore, the *bidirectional nature of exchange* of core human experiences with its campus environment (Stokols et al. 2013, p. 1). Therefore, we used the tenets of resilient and equilibrious self-governing systems to map out how the cross-scale messaging system at a campus might mobilize this bidirectional exchange and work to maintain its equilibrium and resiliency, thereby moving it towards a transformative future. For the remainder of this paper, we highlight an interdisciplinary collaboration at a Talloires signatory university to explore cross-scale communication between academic and managerial units that impacts student experience on campuses with potential influences on resiliency. We use three descriptive case studies from campus efforts to illustrate processes at the academic scale, and an analysis of recent student reflections to demonstrate influences of campus ecological features on student experiences and resiliency.

5 Case Studies from the University of Northern Iowa

Campus open space is a significant part of teaching and learning in programs such as natural resources management, sustainability/ecology, agriculture, forestry, and more recently, in environmental education and sustainable practices (Painter et al. 2013). In 2008, a survey reported that 13.5 % of students selected a school based on sustainability concerns (Grummon 2009). The University of Northern Iowa (UNI) provides an atmosphere that allows diligence, dedication and collaborative efforts among its individuals and their representative units throughout many of the University's entities (e.g., Tallgrass Prairie Center, Biology Department, University's Botanical Center, University's Preserve Committee, Earth Science Department, Physical Plant Facilities, School of Health, Physical Education and Leisure Services, Student Nature Society, etc.). Off-campus partners include the City of Cedar Falls, Black Hawk Soil and Water Conservation District, and Cedar Valley Resource, Conservation and Development. Shared efforts contribute greatly to public awareness of environmental issues and global climate. As an example, UNI received the 2011 Cedar Falls Partnership Award from the City of Cedar Falls for the Wetland Demonstration Park collaborative project between UNI and the City.

Case Study 1: Student designed campus nature trail system: Upon recommendation from a state forester in 2005 to create a recreation trail as an initial step in the thinning process of an overstocked campus savanna, a professor in biology

contacted a professor in parks and recreation for assistance. Out of this conversation, undergraduate students enrolled in an outdoor recreation planning and design course began the process of designing 2.5 miles of nature trails on 35-acres on the southeast aspect of campus. Working with the Assistant Director of Campus Operations Planning, staff and student employees from two campus environmental centers spent 700 h brush cutting, chain sawing, tractor mowing and grooming the trail over three summers (2007–2009), The trail was subsequently extended to create over 5 miles of nature trails meandering through almost 60-acres of green space in the south quadrant of campus. Meanwhile, UNI and the City of Cedar Falls collaborated to create the Wetland Demonstration Park on the northwest side of campus as a part of a larger watershed wide effort for the water quality throughout the City of Cedar Falls, In 2006, UNI and the City initiated a intergovernmental cooperation agreement for the 20 acres surrounding the parks detention pond, allowing UNI to develop the site for recreational, educational and research purposes. UNI also set aside another 20 acres along Dry Run Creek to the west of the detention pond enlarging the park to 40 acres. Late Summer 2008, after construction of the new lake and wet depressions, 10 acres of the area was seeded into native tallgrass prairie. Funds from the Black Hawk Gaming Commission in 2012–2013 created infrastructure for a natural surface trail including flood tolerant crossings, turnpikes, and an observation deck within these 40 acres. These trails were connected to the West Campus Trail that was being formed at this time. In Fall 2014, students enrolled in LYHS 4552 Theory and Practice of Experiential Education planted trees.

- **Nodes of communication**: Faculty, students, facility planning personnel, community agencies, foundation office staff
- **Paths of communication**: Class activities and student presentations to university staff, Grant writing
- **Resource and Management decisions**: Location of trail, maintenance responsibilities
- **Transformative Impact**: Nature trails created for UNI and the larger community, campus preservation and enhancement, educational resource, student satisfaction and empowerment

Case Study 2: Creation of a Certificate in Sustainability: A group of UNI faculty met to create sustainability workshops utilizing the Piedmont/Ponderosa framework (Barlett and Chase 2004) based on the experience of a faculty member who had recently attended a similar workshop. In UNI's sustainability workshop, faculty from diverse disciplines met for two days to engage in sessions on sustainability and systems thinking. The workshop had three goals: intellectual engagement and sophistication, multidisciplinary dialogue, and developing pedagogy for sustainable curricula (Stigliani et al. 2012). The workshop received funding support from the Provost's office and the Recycling and Reuse Technology Transfer Center (RRTTC) on campus. From the knowledge and discussions generated at these workshops, faculty either created a new course or restructured an existing course to

include aspects of sustainability. Simultaneously, lists of courses with sustainable components were created and clustered under six content areas - Natural and Biological Environments, Mathematical and Economic Dimensions, Urban Environments and Technology, Sustainable Tourism and Outdoor Recreation, Teacher Education in Sustainability and Environmental Literacy, and, Social, Philosophical, and Political Dimensions of Sustainability. One required course, *Introduction to Sustainability*, was added to create a 15 credit hour Certificate in Sustainability, open to all students at the University. A system of advisors was created to address student questions regarding the sequence and structure of the Certificate. To date, there are 14 students engaged in the second year, and the number continues to rise. The structure of the Certificate is illustrated in Table 1—students select from electives that are represented from all the Colleges at the University, representing true multidisciplinarity. Moreover, hands-on projects in the Introduction class help students apply their emerging knowledge of sustainability to on- and off-campus projects related to sustainability, thereby building their awareness of points and modes of intervention.

- **Nodes of communication**: Faculty in different departments, RRTTC, Provost's Office
- **Paths of communication**: Presentations and discussion in the 2 day workshop

Table 1 Framework of certificate in sustainability

	Course number and name	Semester planned or completed	Credits	Grade earned
Required	TECH1015: Introduction to sustainability		3	
Electives: *(12 h) Students select from 6 content streams and up to 2 courses from each of content stream*				
Elective 1	Pick from the following content streams: 1. Natural and biological environments 2. Mathematical and economic dimensions 3. Urban environments and technology 4. Sustainable tourism and outdoor recreation 5. Teacher education in sustainability and environmental literacy, and 6. Social, philosophical, and political dimensions of sustainability			
Elective 2				
Elective 3				
Elective 4				
Total			15	
Reflection paper				

- **Resource and Management decisions**: Summer stipends for workshop, Sponsored speakers, Managerial support for Introduction to Sustainability class and publicity materials for certificate
- **Transformative Impact**: Enhanced curricular options for students, Increased understanding of systems thinking among faculty and students, Hands-on experiential learning that impacts campus experiences and student empowerment

Case Study 3: Collaboration across departments for teaching about human-nature interactions: Sustainability concerns often include a holistic attention to indoor and outdoor spaces. A joint research study between two faculty members focused on student use of campus spaces, particularly natural (outdoor) spaces that enable quiet reflection, to identify the perceived effects of campus space experiences on students' environmental sensitivity, health and well-being, and academic learning. Each faculty member taught a course in their discipline (housed in separate colleges)—one focused on stressful and restorative aspects of daily environments (interior design course), and the other centered on park management and design (outdoor recreation course). A common reading was Richard Louv's "The Nature Principle" and a common assignment was a set of reflective responses and a semester summary based on the readings, discussions and experiences with the campus natural environments. The analysis of the semester summaries illustrate links between student well-being and their perceptions of campus landscape in the following ways:

1. *Alleviate stress*—relax, unwind, unplug, reboot, refocus, recharge, regroup
2. *Revitalize mind*—think precisely and innovatively, enhance thinking, organize thoughts, focus, overcome mental obstacles, enhance learning
3. *Exercise*—workout, running, biking, hiking, fresh air
4. *Improve mood*—start day on a happy note, calming, sense of freedom, peaceful, inner spirit connection, pray and recite songs of praise, comfort
5. *Socializing and people watching*—attractive landscaped open spaces help create a strong sense of community, established a campus identity, talking and bouncing ideas off friends

In addition, the interior design students worked on a roof remodel for the student union to create a restorative campus space where students can visit to alleviate stress. In the park management class, students developed themed online "Story Map Tours" to create public awareness of the campus green spaces. In both classes, students gained a heightened awareness of their own campus, and were empowered to visualize changes and improvements in campus spaces that could bolster their own experience in them. The activities, assignments and projects in both classes served as catalysts for their understanding especially because it involved conversations with the campus landscape architect.

- **Nodes of communication**: Faculty and students in two very different domains, Campus Landscape Architect
- **Paths of communication**: Class activities, assignments and projects
- **Resource and Management decisions**: None realized immediately but have future potential (e.g., ideas for roof of student union shared with campus master planning personnel, story maps shared with landscape architect for future dissemination through university website)
- **Transformative Impact**: Students discovered spaces they had not previously visited, more open lines of communication between academic and managerial entities

6 Discussion

Environmental and human conditions of a college or university campus are in continual flux due to systemic demands, shifting parameters and variables, and a pursuit of societal needs such as sustainability. In response to these demands, *structural accretion* and newer sustainability initiatives result in changed configurations in the academic and managerial campus units. However, what types of adaptive responses create the panarchy that can truly balance and transform the university? Some adaptive campus sustainability efforts may have a seemly positive yet short-lived effect, while other efforts make gradual, yet transformational change to the entire campus system. Just as human DNA expression initiates adaptive responses within its environment when thresholds are disrupted, the campus sequence of environment and human DNA strands comprising of the communication nodes and paths prompts adaptive decisions regarding resource use and campus management. For example, in Case Study 1 the need to thin the upland forest for maintaining the health of the forest prompted the student-led design of a nature trail. In Case Study 2, a number of faculty felt that sustainability needed to be infused across the curriculum. When a faculty member attended a workshop based on the Piedmont model, it generated interest in creating UNI's workshop. Regular meetings among faculty interested in sustainability led to the creation and maintenance of a Certificate. In Case Study 3, a need to explore more interdisciplinary connections and applications of the systems perspective to the inside-outside holistic human experience of campus led to a collaboration among faculty in two different academic domains.

Transformative impact was very evident in all three case studies. The nodes of communication represented people from both academic and managerial units of self-governance and also, as in Case Study 1, included the larger nested system of the city. In all three case studies, paths of communication were clear and involved multiple methods that originated as bottom-up channels - that is, the ideas for interaction and transformative change started in the academic circles and percolated up to managerial levels. In the first two case studies, there were clear and

transformative changes in the campus environment (physical environment as well as academic) that occurred because of strategic allocation of campus resources and joint management decisions. Therefore, transformation was influenced by changes in infrastructure, changes in curriculum options, and changes in student resiliency. Particular transformations include newly created trail system where none existed previously, a new interdisciplinary curricular offering on sustainability where none existed previously, and new ways of interdisciplinary thinking where none existed previously in those two domains. The trail now has a life of its own (autopoiesis)—its design now promotes an increasing array of activities and use that now connects human resilience with that of the campus resilience. Student responses in Case Study 3 indicated that the campus environment is more than a static visual experience, it has deeper meanings and effects (such as on stress relief, mood regulation, etc.). Student story maps are rich and illustrative of the different ways to engage with the campus. Student designs for the roof of the campus student union are interesting, innovative, and empathetic. Both assignments offer a vision of a changing campus landscape that can offer more opportunities for students to build their own resilience.

Although challenging due to its complexity, Moran and Lopez (2016) urge that scholars and stakeholders begin to understand the dynamic wholeness of a multi-scale system by "developing the capacity to speak across the disciplinary divides, understand the assumptions of others across the table, have a systems perspective, and work to comprehend the complexity of the human-environment systems rather than seek to simplify them" (p. 2). Using human DNA and its communication mechanism as a metaphor, we presented three case studies to identify how human and ecological sustainability strands might interact to enable resilience of a self-organizing university campus system. Three key cross-scale enablers of social-ecological resilience that link the strands include (a) *nodes of communication*, or the key individuals within academic and managerial university units that are loosely linked and have the flexibility to self-organize, (b) the *paths of communication*, or the method of information exchange through intermediaries, and (c) the *campus resource and management decisions*, related to its past, present, and future sustainability efforts. Our case studies also illustrated either actual physical design change of the campus (trails) or future potential (story maps and roof designs) that demonstrate deep value of participatory design approaches for student empowerment and resiliency and the potential of the campus as a 'living laboratory.' In three scenarios for future sustainable development of universities, Beynaghi et al. (2015) refer to socially-oriented, environmentally-oriented, and economically-oriented universities. While the ideas in our paper align well with the second of these scenarios, they significantly extend the discourse by suggesting how the ecological and human dimension *strands* of the campus units can better communicate to yield transformative results that map college campus interactions and their influence on socio-ecological resilience. Like a recessive gene, does the human dimension of sustainability get trumped or remain in the background by dominant ecological efforts? Or, can it be brought to the forefront through timely nodes of cross-scale communication as this paper highlights?

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Author Biographies

Gowri Betrabet Gulwadi, Ph.D., LEED AP teaches in the interior design program at the University of Northern Iowa (UNI) in Cedar Falls, Iowa. She facilitates the learning process of design students, emphasizing the importance of socio-cultural context and sustainable design. Along with other sustainability leaders at UNI, she helps develop faculty initiatives for infusing sustainability in the curriculum. Her research addresses health and restoration from stress, and the particular ways in which people seek it in their everyday environments. Her writings can be accessed in the following journals – *Environment and Behavior, HERD Journal, Journal of Aging Studies, Journal of Housing for the Elderly, Interiors,* and the *International Journal of Sustainability in Higher Education*. She has served on the Board of Directors, of the Environmental Design Research Association (EDRA). Her other professional affiliations include the Interior Design Educators Council (IDEC) and the International Association of People-Environment Studies (IAPS).

Dr. Kathleen Scholl has been a faculty member of the Leisure, Youth and Human Service Division within the School of HPELS at the University of Northern Iowa (UNI) since 2001. She received her doctorate from the University of Minnesota in 2002. She teaches undergraduate and graduate courses in Outdoor Recreation Management, Outdoor Education, Research and Evaluation, Philosophical Foundations, and Social Psychology of Leisure. Dr. Scholl integrates practical experiences for her students to apply current best practices to outdoor recreation planning

and programming. For example, outdoor recreation students were involved in the design and development of interpretative trails for the UNI campus. Dr. Scholl is a member of NE1962 USDA Multi-State Initiative: Outdoor Recreation, Parks & Other Green Environments: Understanding Human & Community Benefits and Mechanisms. In addition to Dr. Scholl's interest in recreation planning and programming, she is a Certified Therapeutic Recreation Specialist (CTRS). Her research interests include: human-environment interactions, ecosemiotics, outdoor leadership and communication effectiveness, sustainability, outdoor recreation and community development, inclusive recreation, accessibility, parent advocacy and support for families with disabilities.

Developing Sustainability Competence for Future Professional Accountants: The Integrative Role of an Undergraduate Program

Artie W. Ng, Tiffany C.H. Leung and Jack M.K. Lo

Abstract

To instigate the conception of sustainability in education, it takes a top-down commitment from the administration of a tertiary institution as well as a bottom-up initiative stimulating interests of its faculty and students to collaborate learning proactively. This Chapter aims to develop a conceptual framework that adopts a model of knowledge development for the attraction of sustainability competence of a new generation of professional accountants. A personal knowledge management model is advocated for students of a tertiary education program to develop their explicit and tacit knowledge needed for sustainability competence. Through a case study of an undergraduate program in accountancy in Hong Kong, it highlights the integrative role of an undergraduate program that is designed with an emphasis on the ethical aspects of corporate social responsibility (CSR) and knowledge about sustainability. Standalone compulsory and elective courses integrated with a program of learning and teaching activities with involvement of students would engender a dynamic process for sustainability competence as a higher order of learning beyond the confines of vocational education. The significance of pertinent faculty research activities and transferring contemporary knowledge about sustainability with local relevance is pointed out.

A.W. Ng (✉) · T.C.H. Leung · J.M.K. Lo
School of Professional Education & Executive Development, College of Professional & Continuing Education, The Hong Kong Polytechnic University, Hong Kong, China
e-mail: spartie@speed-polyu.edu.hk

T.C.H. Leung
e-mail: chleung@speed-polyu.edu.hk

J.M.K. Lo
e-mail: spjacklo@speed-polyu.edu.hk

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Sustainability competence · Tertiary institution · Personal knowledge management · Accounting education

1 Introduction

Changes in externalities and regulatory reforms in the international financial markets have brought about challenges to professional accountants as they are identified as a key corporate facilitator for sustainability accounting and performance (IFAC 2011). The future generation of professional accountants is expected to possess pertinent cross-disciplinary knowledge and skills to deal with such emerging interrelated issues, particularly corporate social responsibility (CSR) and sustainability.

Hong Kong has in the recent decades gradually emerged as an international financial center and its stock market has also become one of the largest stock exchanges in the world in terms of market turnover and the amount of capital raised through initial public offering (IPO). After 1997, Hong Kong has been positioning itself strategically as the global financial center of China as China's state-owned enterprises (SOEs) and entrepreneurial firms continue to raise capital through listing with the stock exchange of Hong Kong. Against such a background, the profession of accountancy has steadily become a popular career path among the youngsters. In fact, the Hong Kong-based professional accountants continue to play an important role in supporting a wide range of pertinent professional services, namely, auditing, taxation, corporate financial reporting, management controls, compliance and internal audit. As China continues its globalization route, these listed enterprises have entered into cross-border mergers and acquisitions transactions. Chinese emerging multinationals utilizing the platform of Hong Kong to execute cross-border transactions are driven to comply with its financial regulations and related international practices. Hong Kong-based professional accountants with international exposures are driven to offer related professional services as Hong Kong follows closely the international practices, embracing the increasing interests in corporate social responsibility (CSR) and related disclosures.

In light of these challenging externalities, this paper aims to examine how the professional knowledge and sustainability competence of future accountants would possibly be developed through tertiary education. It starts with a literature review to look into knowledge management and competence development models. Building on a proposed framework, it examines the case of an undergraduate accounting program in Hong Kong—being positioned as a global financial centre in Asia. An outcome-based program development approach is revealed in its design for nurturing the next generation of professional accountants while meeting institutional-level intended outcomes and professional accreditation requirements.

Building upon the students' experience engaged in various curriculum activities as embedded in the program, this study postulates that knowledge development for the next generation of accounting professionals can be initiated from a tertiary institution that emphasizes the values of global citizenship and professional ethics utilizing the integrative role of an undergraduate program. In meeting the outcome-based objectives, its curriculum activities are designed with a compulsory subject in CSR, combined with other complementary learning and teaching activities.

2 Literature Review

2.1 Education About Sustainability for the Next Generation of Accountants

Financial regulations pertinent to professional accountants have been intensified in the last decade subsequent to the global financial crisis started out in 2008. There are concerns over the efficacy of audited financial information in relation to systematic risk in the capital market as well as role of professional accountants in safeguarding the stakeholders' interests. Professional accountants are expected to be well-versed with latest knowledge about international practices of enterprise risk management, internal control and corporate governance. And more recently, accountants are asked to look into integrated reporting approaches that provide pertinent information about CSR and sustainability as relevant to the capital market. As the global financial center of China, Hong Kong is in the forefront in adopting practices and standards as embraced by international accounting bodies on sustainability reporting. In particular, International Federation of Accountants published its document on Sustainability Framework highlighting such implications for professional accountants (IFAC 2011).

Similar to other international financial centers, Hong Kong has attempted to develop its Environmental, Social and Governance (ESG) guidelines for companies listed on its stock exchange in light of the growing importance of corporate disclosures on social, environmental and sustainability considered as useful for decision making in responsible investing (HKEC 2015). The United Nations has developed United Nations-supported Principals for Responsible Investment Initiatives (UNPRI 2015) with an attempt to reinforce more responsible investments around the world. According to UNPRI (2015, p. 1), "*Responsible investment is an approach to investment that explicitly acknowledges the relevance to the investor of environmental, social and governance factors, and of the long-term health and stability of the market as a whole; it recognizes that the generation of long-term sustainable returns is dependent on stable, well-functioning and well governed social, environmental and economic systems.*"

In fact, engaging the next generation of accountants in education about sustainability has been identified as critical for them to understand the issues as they

will be facing more about such challenges in their generation to come (Bebbington 1997; Gray 2013). Another recent study reveals the significance of engaging students in the first place for interest in sustainable living (Chaplin and Wyton 2014). There are various proposed methodologies for engaging students to learn about sustainability issues. One of the prior studies looked into how a stand-alone course really would make a contribution to education for sustainability and advance sustainability learning outcomes, suggesting that an interaction among the class participants could also enable exploration the meaning of sustainability (Lee 2012).

Another prior study looked into the benefits of problem- and project-based learning initiatives (PPBL) in the implementation challenges of sustainability education in university programs through adequate institutional structures and concerted efforts by an organization as a whole (Wiek et al. 2014). It points out the importance of facilitating top-down commitments from the administration and bottom-up drive from interested faculty and students. Looking into the development of sustainability education in Asia, Wu et al. (2015) argues that there is a growing need for interdisciplinary integration as there are various sustainability courses offered by business, science and engineering schools. Asian universities can leverage on developing international connections to share knowledge and promote active promotion of sustainability education as a global initiative.

2.2 Competence for Sustainability

However, the necessary competence for sustainability to be incorporated into education is yet to be fully developed. Fleming (1991) argued that there are competences which work on other competences and conceptualized as meta-competence. It is the "versatility" of a student to deal with a variety of problems by deploying appropriate skills and knowledge to the circumstances. In fact, meta-competence can be developed through aligning subject-specific knowledge with the particular competences as practiced by the learner. A general definition of competence was proposed by Cheetham and Chivers (2005) to emphasize an effective performance observed within an occupation, which could range from fundamental proficiency to a level of excellence (Cheetham and Chivers 2005, p. 54). For tertiary education in applied-knowledge based or professional programs, it is quite critical to develop competence of a student in preparing them for future employment in the industry (Kwok et al. 2014).

For instance, Cheetham and Chivers (1996) proposed a holistic model of professional competence which consists of four key components: functional competence; personal or behavior competence; knowledge/cognitive competence; and values/ethics competence, as summarized in Table 1.

Sustainability competence as identified in previous studies can be categorized into (i) systems thinking competence, (ii) anticipatory competence, (iii) normative competence, (iv) strategic competence and (v) interpersonal competence (Wiek et al. 2011; Rieckmann 2012). To ensure implementation, it is necessary to integrate such key competencies in order to guide the design of programs and courses

Table 1 Types of competence

Types of competence	Range of abilities
Functional competence	It is the ability to perform a range of work-based tasks effectively to produce specific outcomes. This includes, and indeed requires, the passion of discrete skills but the emphasis is on putting these to use to achieve specific outcomes
Personal or behavior competence	It is the ability to adopt appropriate, observable behavior in work-related situations
Knowledge/cognitive competence	It is the possession of appropriate work-based knowledge and the ability to put this to effective use
Values/ethics competence	It is the possession of appropriate personal and professional values and the ability to make sound judgments based upon these in work-related situations. The linkage of ethical competence with values emphasizes the point that values, like knowledge, are of little use unless they are effectively applied. This ethical competence refers to the effective and appropriate application of values in professional settings.

Source Cheetham and Chivers (1996)

in sustainability, teaching and learning, as well as recruitment and development of faculty and staff. Tertiary institutions also need to consider opportunities for continuous improvement through various means. There should be certain "theoretical justifications" on how proposed competencies could contribute to problem solving in sustainability. It is also advantageous to collect empirical evidence to demonstrate how such competencies could deal with real-world sustainability issues and relevant research is considered complementary to the overall development of sustainability competence (Wiek et al. 2011; Rieckmann 2012).

With respect to implementation, Brundiers et al. (2010) point out that it is necessary to enhance competence with real-world learning through project- and problem-based learning, service learning, and internships in communities, businesses, and governments as real-world learning opportunities. These real-world learning opportunities if designed well would be conducive for students to be involved in collaborative research between academic researchers and practitioners. An incremental approach would allow building competencies of these students with skills in problem solving, linking knowledge to action in a team-based environment with application of concepts and methods to enhance sustainability competence.

2.3 Leveraging Personal Knowledge Management as a Step-Forward

To strengthen the competence model, it is worthwhile to look into the concept of knowledge management in building up sustainability competence that requires constant accumulation of pertinent interpersonal competence as noted by (Wiek et al. 2011). As proposed by Nonaka and Takeuchi (1995), there are four modes of knowledge conversion namely Socialization, Externalization, Combination and

Internalization (SECI) in this knowledge-conversion spiral model as illustrated in Fig. 1. Accordingly, in the SECI model, **Socialization** contemplates transferring tacit knowledge by face-to-face communication or shared experience. **Externalization** refers to converting the tacit knowledge to explicit knowledge by developing specific concepts that embrace the combined tacit knowledge. **Internalization** is about turning the explicit knowledge to tacit knowledge whereas **Combination** is a process of integrating explicit knowledge together. These conversion processes need to interact dynamically in the spiral of knowledge creation. Knowledge capital would be further developed at an organization level (Chatzkel 2003).

Personal learning is considered as an important feature in enhancing knowledge management on an individual basis (Pauleen 2009; Avery et al. 2001; Garner 2010). According to Avery et al. (2001), there are six main elements under Personal Knowledge Management (PKM), namely, retrieving (PKM1), evaluating (PKM2), organizing (PKM3), analyzing (PKM4), collaborating (PKM5), presenting (PKM6) and securing (PKM7). PKM would play an important role in the KM process for both individuals and their organizations that would benefit from improved competence of their human capital. It is revealed that the values of PKM for individuals are likely to be correlated to those of their organizations (Cheong and Tsui 2010). Individuals could achieve a higher level of competence through a self-fulfilling PKM approach with knowledge management capability through researching reliable knowledge for their continuing professional development in sustainability competence.

3 Framework

3.1 Design of Tertiary Education

Tertiary education is recognized as a well-structured, conducive means for an individual to develop their knowledge and skills needed in preparation for lifelong developments in a knowledge-based economy. However, there are critics about efficacy of degree programs in preparing students for the real-life challenges. In particular, students may not have obtained the necessary competence needed for an industry before they graduate. When designing a tertiary education program, there should be consideration of the competence needed for student development to enhance their employability (Kwok et al. 2014).

From the standpoint of a tertiary institution, such a competence development objective can be embedded within a balanced approach of performance evaluation as instituted in the overall design and management of education programs (Hughes and Pate 2013; Ng et al. 2015). On an individual program basis, quality education

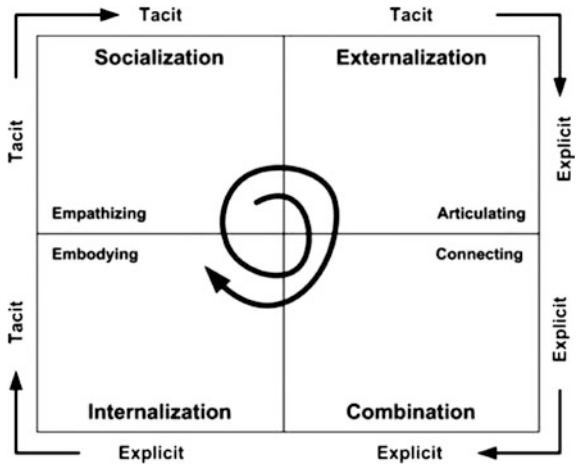

Fig. 1 SECI Model Source Nonaka and Takeuchi (1995)

should also consider the perspectives of students as to how learning works. In prior studies, some of the important elements for learning are summarized as: (i) sources of motivation, (ii) prior knowledge, (iii) experiential learning, and (iv) dealing with limitation of student learning caused by avoidance or ignorance (Kolb 1984; Ambrose et al. 2010). When designing an education, it is quite a challenge to incorporate appropriate activities of teaching and learning that involve keen participation of students in enhancing their competence development.

3.2 A Competence-Based Approach for Program

In dealing with such a challenge, we explore a competence-based enhancement approach through a PKM development spiral with adaption of the SECI model for program development as provided in Fig. 2. A tertiary education institution has particular roles as embedded in the revised model. It assumes the integrative role of tertiary education programs with respect to both tacit and explicit knowledge and skills for sustainability competence. Through matching discrepancies in competence, a tertiary education program can be utilized to bridge expectations of stakeholders – students vs. industry. It is proposed that there should be four main components in an accounting program: (i) Developing curriculum as the foundation knowledge; (ii) Integrating learning outcomes; (iii) Accreditation with international professional associations; and (iv) Designing complementary competence development through teaching and learning activities (see Fig. 2).

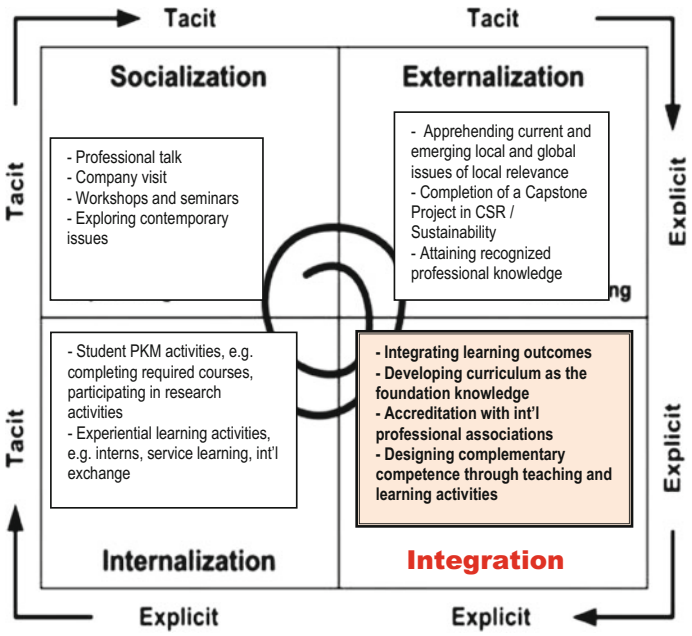

Fig. 2 Program as a dynamic integrator for sustainability competence. *Source* Adapted from Avery et al. (2001), Nonaka and Takeuchi (1995)

4 Case in Point

4.1 Case Study Approach

This paper adopts a single case study approach to enhance the development of a conceptual framework that adopts a model of knowledge development for sustainability competence of future professional accountants as human capital of the society (Also see Yin 2003). Pettigrew (1985, p. 242) defines an in-depth case study as "developing and refining generalizable concepts and frames of references". This approach involves the empirical examination of "a particular contemporary phenomenon with is real life context using multiple sources of evidence" (Robson 2002, p. 178).

The authors select a rich case of an undergraduate program, Bachelor of Business Administration (Hons) in Accountancy (Program) offered by the School of Professional Education and Executive Development at The Hong Kong Polytechnic University (PolyU) is exemplified for this study. Relevant program validation documents have been collected and reviewed. The authors involved in the program also share their experience in relation to the pertinent program and course development as an action research approach to enrich this case study (Greenwood and Levin 2007).

This program is designed to equip students with necessary professional knowledge and skills in various aspects of accounting and business administration so as to prepare them to pursue a career in professional accounting. Despite its focus on professional accountancy, it is critical to note that a university education should aim beyond merely mastering accumulation of factual knowledge. It is vital to develop students' ability to solve problems and think critically, especially when dealing with ethical issues. These focuses reflected from the initial program objectives are implemented in the teaching approaches and evaluation of student performance. The underpinning curriculum and program design principle is based on the philosophy of outcome-based learning embraced by the institution. An outcome-based curriculum provides a rigorous and robust delineation of the professional competence. It develops the generic abilities that are considered important for the graduates of the program.

Explicitly specified outcomes give a clear direction as to how teaching and assessment of students should be planned, aligned, and carried out. This approach is meant to enhance coherence and integration among subjects within the program. Through an interactive process, students are encouraged to take responsibility for their own learning in an outcome-based curriculum. When learning outcomes are stated clearly, students are able to plan their own learning more effectively. Students graduating from the program are expected to have necessary professionally-specific skills and knowledge to make an immediate contribution to the organization in which they are first employed. They should possess a foundation of professionally-specific skills and knowledge that would reinforce a process of continuous professional development.

However, there are a number of limitations of using a single case study approach. First, due to the contextual uniqueness of this case study, a conceptual framework could not be fully generalized or transferred to other settings or contexts. Second, the focus of this study has been limited to an undergraduate program, Bachelor of Business Administration (Hons) in Accountancy (Program), rather than to explore beyond an undergraduate degree and across multiple disciplines. Third, this article has been focused on students, but it did not examine with external stakeholder groups in general, and internal stakeholder groups in the institution in particular. Fourth, this study has been only confined to a single institution in Hong Kong without comparing other institutions at the local level, other Asian countries at regional level, or other western countries at international level.

4.2 Integrating Learning Outcomes

As a tertiary institution, PolyU has the vision to be a leading university that excels in professional education, applied research and partnership for the betterment of Hong Kong, the nation and the world. To reflect its unique positioning as an institution, the following are the six specific institutional learning outcomes of PolyU:

(i) Competent professional: "*Graduates should be able to integrate and apply in practice the fundamental knowledge and skills required for functioning effectively as an entry-level professional*";
(ii) Critical thinker: "*Graduates should be able to examine and critique the validity of information, arguments, and different viewpoints, and reach a sound judgment on the basis of credible evidence and logical reasoning*";
(iii) Effective communicator: "*Graduates should be able to comprehend and communicate effectively in English and Chinese, orally and in writing, in professional and daily contexts*";
(iv) Innovative problem solver: "*Graduates should be able to identify and define problems in professional and daily contexts, and produce creative and workable solutions to the problems*";
(v) Lifelong learner: "*Graduates should recognise the need for continual learning and self-development, and be able to plan, manage and improve their own learning in pursuit of self-determined development goals*"; and
(vi) Ethical leader: "*Graduates should have an understanding of leadership and be prepared to lead a team, and should acknowledge their responsibilities as professionals and citizens to the society and their own nation, and be able to demonstrate ethical reasoning in professional and daily contexts*".

Further, to echo the global development of sustainable campus, PolyU has released its Sustainability Policy to strive for excellence in education and research by integrating sustainability concepts into program curricula, research activities and increasing awareness of sustainability among staff and students through promotional activities, campaigns and cultural development. One of such policy goals is to establish on PolyU campus a teaching, learning, and research environment, which is conducive to sustainability.

At the Program level, there are another set of objectives which largely aim to equip students with necessary professional knowledge and skills in various aspects of accounting and related disciplines for them to pursue careers in business and professional development. There are six identified program learning outcomes as validated by a group of academic and professional experts in the field that are designed in part to fulfill the institutional learning outcomes (see Table 2). In particular, students at the program level are expected to learn how to identify and resolve various ethical issues as they arise generally and in business context as well as to demonstrate a global outlook in setting business objectives and taking actions for organizations. In achieving the designed learning outcomes, students graduating from the program are expected to: (i) possess necessary professionally-specific skills and knowledge to make an immediate contribution to the organization in which they are first employed and (ii) attain the foundation of professionally-specific skills and knowledge, on which to base the process of continuous professional development.

Table 2 A matrix for fulfilling institutional learning outcomes with program learning outcomes

		Programme Learning Outcomes					
		a	b	c	d	e	f
Institutional learning outcomes for undergraduate	Competent professional	✓	✓	✓	✓	✓	✓
	Critical thinker		✓	✓	✓		✓
	Effective communicator	✓					
	Innovative problem					✓	
	Lifelong learner	✓		✓		✓	✓
	Ethical leader		✓		✓		

Source Program document

4.3 Developing Curriculum as the Foundation Knowledge

To achieve program-level learning outcomes, a wide range of compulsory and elective subjects are being offered in the Program (see Table 3 for the list of these courses). In light of the global attention to corporate social responsibility and sustainability, the program has incorporated subjects and related learning activities that are instrumental for learning ethical issues and the contemporary global outlook about social and environmental sustainability.

One of the compulsory subjects in Accountancy Program—Corporate Social Responsibility intends to develop the foundation of the students' knowledge through examining the corporate interactions with stakeholders as well as ethical, social and environmental responsibilities. It contributes to the achievement of the program learning outcomes by enabling students to demonstrate a global outlook as well as to explore pertinent ethical issues and potential mitigating measures through local, regional, and international cases. Upon completion of the subject, students are expected to able to: (i) evaluate the international approaches and standards in reporting and disclosures of corporate social responsibility and sustainability issues by organizations; (ii) analyze "ethical issues" within the framework of corporate social responsibility with different approaches for different value systems; and (iii) apply appropriate ethical concepts and approaches in realistic corporate and professional circumstances.

Other subjects, Management Accounting (compulsory) and Risk Management (elective), have integrated topics and case studies about sustainability reports, sustainability performance and sustainability risk as embraced as relevant topics for the professional accountants.[1] These embedded contents enable students to learn the real-life and professional issues related to sustainability in a corporate and professional setting. In addition, all students are required to complete a final-year

[1]COSO released a paper in 2013 titled "Integrating the triple bottom line into an enterprise risk management program" emphasizing the growing significance of sustainability risk.

Table 3 Compulsory and elective subjects in the program

Subject	Level
Compulsory subjects (20 subjects, 3 credits each)	
SPD3215 Workplace english for business students	3
SPD3216 Chinese Language Communication for Business	3
SPD2297 Management accounting 1	2
SPD3217 Management accounting 2	3
SPD3219 Intermediate accounting 1	3
SPD3219 Intermediate accounting 2	3
SPD4473 Auditing and assurance 1	4
SPD4474 Accounting information systems	4
SPD3220 Hona Kong tas frame work	3
SPD3221 Business finance	3
SPD4475 Corporate finance	4
SPD2293 Introduction to business law	2
SPD3222 Company law	3
SPD3223 Operations management	3
SPD3224 Global economic environment	3
SPD4476 Corporate social responsibility	4
SPD4477 Advanced financial accounting	4
SPD4478 Strategic management	4
SPD4479 Business research methods	4
SPD44S0 Capstone project	4
Elective subjects (any 2 subjects, 3 credits each)	
SPD4304 China business management	4
SPD4492 Financial statement analysis	4
SPD4482 Information systems audit and control	4
SPD4483 Auditing and assurance 1	4
SPD4484 Corporate governance and compliance	4
SPD4250 Marketing management	4
SPD4081 Human resource management	4
SPD4423 Cross-cultural management	4
SPD4526 Risk management	4

Source Program document

project as a graduation requirement by completing the compulsory Capstone Project. In a recent cohort, more than half of the students have opted for a topic related to CSR and/or Sustainability among other topics in accounting or business, demonstrating their self-motivated interests in such a topic that is relevant to their generation and time to come.

Table 4 Summary of accreditation arrangements by the Program

• Entering the qualification program (QP) of the Hong Kong Institute of Certified Public Accountants (HKICPA)
• Receiving exemption from Papers F1 to F9 of the professional examinations of the Association of chartered certified accountants (ACCA) provided that they have taken the subjects requested by the ACCA
• Entering the CPA Program of CPA Australia
• Receiving partial exemption from the professional examinations of the Hong Kong Institute of Chartered Secretaries (HKICS)/Institute of Chartered Secretaries and Administrators (ICSA)
• Receiving partial exemption from the professional examinations of the Chartered Institute of Management Accountants (CIMA)

Source Program document

4.4 Accreditation with International Professional Associations

As an externalization initiative of the Program, it has been accredited by the local and various internationally recognized accounting associations (See Table 4). Through fulfilling the qualification programs and requirements of the local one—Hong Kong Institute of Certified Public Accountants (HKICPA), graduates of the program are able to pursue a professional career in accounting more directly and effectively. HKICPA is a self-regulating body governing the professional conduct of accounting professionals in Hong Kong.[2] HKICPA members are recognized internationally as there are mutual recognition agreements in place with the chartered accountant institutes of Australia, Canada, England and Wales, Ireland, New Zealand, Scotland and U.S.

Given the global concerns about sustainability issues, the accounting profession in response needs to apprehend pertinent cross-disciplinary knowledge and skills to deal with emerging contemporary issues, particularly corporate social responsibility and sustainability. As Integrated Reporting has been advocated as an international approach for corporations to disclose pertinent information about CSR and sustainability, professional accountants in the future are expected to take a vital role in providing such additional managerial reporting and disclosures in addition to the traditional financial reporting function (IFAC 2015). The above accreditation requirements as embedded in the Program would enable constant updates on the professional requirements on knowledge pertinent to sustainability competence.

[2]According to HKICPA, its total membership number reached 36,867, while practising members increased to 4223, with 2219 firm and corporate practices as at end-April 2014 (http://hong-kong-economy-research.hktdc.com/business-news/article/Hong-Kong-Industry-Profiles/Accounting-Industry-in-Hong-Kong/hkip/en/1/1X000000/1X003UJZ.htm#sthash.Fpb8wL4h.dpuf).

4.5 Designing Complementary Sustainability Competence Through Teaching and Learning Activities

Through various internalization and socialization activities beyond regular courses, students develop their sustainability competence as well as both explicit and tacit knowledge through learning activities outside the classroom as embedded in the Program. Some of these activities are summarized in Table 5.

5 Discussion

In this case study, it exemplifies the importance of the integrative role of tertiary education programs in developing the sustainability competence of students in preparation for their career development. Through looking into the case of an undergraduate program, we point out the needs to develop both tacit and explicit knowledge for future professional accountants as illustrated in the framework through a dynamic process. Students' awareness of the need to acquire explicit professional knowledge is emphasized. At the same time, the students recognize the need to develop tacit knowledge through learning activities outside the classrooms. These activities would be considered as reality check on tacit knowledge development that enhances sustainability competence of the profession.

Instead of focusing on vocational training, this case demonstrates that students can acquire heterogeneous knowledge for building up their specific sustainability competencies that are locally and globally relevant (see Table 6). Academics have an independent role in transferring knowledge that is considered critical for educating the professional accountants beyond what it is currently relevant to the industry. To fulfill such a purpose, they can conduct research to examine

Table 5 Learning and teaching activities for sustainability competence

Type of activities	Examples
Participating in professional talks and events	– Attending International Symposium on Corporate Social Responsibility for Innovation and Sustainability with Big-4 partners and seasoned academics as the keynote speakers
Engaged in sustainable campus development activities	– Participating in green lifestyle promotion activities and related campaigns
Completing General University Requirements (GUR) subjects	– An option to complete GUR subjects concerning world sustainability, such as "Living on a Dynamic Earth" and "Climate Change and Society" offered in the summer semester – Development of Service Learning subjects in collaboration with an NGO with a mandate in environmental sustainability

Source The authors

Table 6 Specific sustainability competencies

Types of competence	Specific sustainability competencies
Functional competence	• Ability to identify and recognize CSR/Sustainability reporting approaches and methods • Knowledge about methodology for sustainability risk assessment
Personal or behavior competence	• Ability to articulate and communicate sustainability issues in relation to the society and the business community. • Independent thinking and research skills to examine the issues involved.
Knowledge/cognitive competence	• Awareness of the on-going regulatory and professional concerns about sustainability on both local and global bases
Values/ethics competence	• Strategic thinking about sustainability issues ranging from ethical points of view to strategic issues about an organization's contribution to sustainability of the local region and the world

implications for the future sustainability competence of their students as much as feasible. An adapted SECI model provides a framework for continuous learning and teaching activities in the development of sustainability competence. This is a higher order of learning outcome which goes beyond vocational education.

6 Concluding Remarks

In summary, the main purpose of this article is to develop a conceptual framework of a competence-based enhancement approach that largely adopts a model of personal knowledge development (PKM) (Avery et al. 2001) and the Socialization, Externalization, Combination (SECI) model (Nonaka and Takeuchi 1995) for program development. This study points out that a major role of higher education in business is to be sensitive to the on-going changing dynamics of the business world. There are new skills and knowledge which are expected of the next generation of professional accountants. These future graduates should be competent in making ethical judgment, aware of pertinent regulatory issues, versatile in reporting on sustainability performance as well as analytical in assessing sustainability risks. To a certain extent, these future professionals would help safeguard and augment the accountability and performance of corporations towards sustainability of the world.

This article further highlights the significance of pertinent faculty research activities and transferring contemporary knowledge about sustainability of local relevance. Scholarly and research activities of an academic related to sustainability is of vital importance in building up knowledge to enhance development and relevance of a tertiary education program. Through the integrative role of an undergraduate program, active participation of students in outside-classroom learning activities could be deliberated to strengthen their confidence in developing community-based solutions for environmental sustainability. Well-designed service learning approach which engages the local community would enable the students to

appreciate not only environmental sustainability but also social sustainability at large.

This article has employed an in-depth single case study approach to explore an undergraduate program, Bachelor of Business Administration (Hons) in Accountancy (Program) in the context of Hong Kong. The extent of this proposed conceptual framework varies by institution and country (culture) and thus this study could only be applicable to similar settings or contexts. There are a number of possible further studies in this field. First, further research is extended to examine the sustainability competence beyond the undergraduate level and see how the postgraduate level and the doctorial level could contribute an integrative role of sustainable education. Second, further studies could examine the similar research field from an undergraduate level across faculties or disciplines. Third, future studies could explore the relationship between institutions and other external parties, such as the government, the local community and NGOs, which collaborate with the institutions to enhance social and environmental sustainability. Fourth, further research could compare and contrast the sustainable competence from multiple institutions at local level or various institutions from Asian and Western contexts.

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Authors Biography

Dr. Artie W. Ng is currently Principal Lecturer and Deputy Director with School of Professional Education & Executive Development at The Hong Kong Polytechnic University (PolyU). He obtained his Ph.D. degree from the Adam Smith School of Business at the University of Glasgow (Scotland). Dr. Ng has a research interest in sustainability performance of knowledge-intensive organizations. He has published with international academic and professional journals, including Renewable & Sustainable Energy Reviews, Journal of Sustainable Finance & Investment, Journal of Intellectual Capital, International Journal of Health Care Quality Assurance and Corporate Governance Asia, etc. He is currently an International Associate with the Centre for Social and Environmental Accounting Research at the University of St Andrews. He is also a fellow member with both HKICPA and CIMA (UK).

Dr. Tiffany C. H. Leung is a Lecturer in School of Professional Education & Executive Development, College of Professional & Continuing Education, The Hong Kong Polytechnic University. She gained her doctorate from the School of Management at the University of St Andrews (Scotland) in 2014. Her research interests are in Corporate Social Responsibility, Corporate Social Disclosure, Sin Industry, and Business Ethics. She also teaches classes on Corporate Social Responsibility, Professional Ethics and Social Responsibility, Business Research Methods, Strategic Management, and Accounting for Decision Making. She would like to thank all the accounting students who have taken Corporate Social Responsibility for the development of this book chapter.

Dr. Jack M. K. Lo is the Director of School of Professional Education and Executive Development (SPEED) of The Hong Kong Polytechnic University. Dr. Lo was formerly the Assistant Professor of Public Sector Management and Programme Director of the MSc Programme in Public Sector Management at the Department of Management of PolyU. He also held a number of positions in PolyU including Programme Director in SPEED and Acting Head of Hong Kong Cyber University. His research interests are in the realms of local governance, environmental management, administrative and public sector reform and bureaucratic corruption. He is the Editor of Public Administration and Policy.

Linking Space and Nature Syntaxes: The Influence of a Natural View Through Observed Behaviour at Arcosanti, Arizona, USA

Karen Munro and David Grierson

Abstract

The world's urban population is rapidly growing, now exceeding its rural population, and is expected to reach 70 % of the world's total by 2050. Research in environmental psychology increasingly supports the Biophilia Hypothesis which holds that our connection with Nature is innate. Thus, how do we maintain a human connection to Nature in an increasingly urbanising world? The research explores the boundary between built and natural environments, specifically how proximity, initially through visual connections, to Nature affects how people use social spaces. Case study work is being undertaken at Arcosanti urban laboratory in the Arizona desert. Through development of a Space/Nature Syntax methodology applied within a uniquely compact urban form, this research attempts to understand how maintaining an instinctive bond with Nature can enhance social interactions and inform future design choices within built environments. Initial results support relationships of varying strengths between spatial connectivity, visibility of Nature, and types of social interactions. This paper explores the potential of the cross-disciplinary Space/Nature Syntax methodology as a design and analysis tool, projecting where social interactions within a built space could be influenced by visibility of Nature; where informed design can allow for the essential human/Nature connection to thrive.

K. Munro (✉) · D. Grierson
Department of Architecture, University of Strathclyde, 75 Montrose Street, G1 1XJ Glasgow, UK
e-mail: karen.munro@strath.ac.uk

D. Grierson
e-mail: d.grierson@strath.ac.uk

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1 Introduction

In 1984, E.O. Wilson proposed the Biophilia Hypothesis, a theory which presented the relationship between humans and Nature as innate. He proposed that humanity's connection with Nature was essential, had evolved to be mentally and physically beneficial, and that the increasingly prominent shift from rural living to urban living was detrimental to humanity's collective well-being (Grinde and Patil 2009).

Wilson was not the first person to recognise the strength of humanity's appreciation of Nature; Romanticism saw writers and artists recognise the importance of Nature as cities grew due to the Industrial Revolution. In 1854, Thoreau wrote: "*There are moments when all anxiety and stated toil are becalmed in the infinite leisure and repose of nature",* while Leo Tolstoy is often quoted as saying *"One of the first conditions of happiness is that the link between Man and Nature shall not be broken."* Recently, this connection between humans and Nature has become a significant field of study as researchers seek to explore and explain this undeniable bond. A number of studies have shown proximity to Nature can have physiological and psychological benefits including relieving stress and alleviating psychological disorders. (Berman et al. 2008, 2012; Ward Thompson 2011; Wilson 1984; Keniger et al. 2013; Logan and Selhub 2012; Cervinka et al. 2012; MacKerron and Mourato 2013; Gehl et al. 2006).

Wilson, Thoreau, and Tolstoy shared an opinion that scientific study has arguably now proven; that a human-Nature connection is vital, beneficial and innate. However, as the global transition from rural to urban shows no signs of slowing, an increasing portion of the world's population has lost or faces losing this connection with the natural environment; the world's global urban population already exceeds 50 % and this is due to increase to 70 % by 2050 (W.H.O. 2012). Living in urban areas has been linked to many of the concerns that proximity to Nature assists; stress, depression, mood disorders and anxiety (Srivastava 2009; Sengupta and Benjamin 2015; Benedictus 2014; Adli 2011). As populations shift and cities grow, it becomes increasingly difficult to connect people with true Nature; "wilderness". However, there is evidence that even minor interventions of Nature into our built environments can be beneficial. A study focussed in health care architecture discovered that a view of a natural environment reduced surgery recovery times (Raanaas et al. 2012); while other studies have focussed on the benefits of introducing natural elements such as office plants to internal spaces (Brown and Bell 2007). There is, therefore, both a need and an opportunity for architects and

planners to understand how they can design built environments which nourish humanity's seemingly biological need for proximity to Nature.

2 Arcology (ARChitecture + EcOLOGY) and Arcosanti

Arcology is a concept developed by architect Paolo Soleri (1919–2013), as an alternative to modern US cities, where reliance on vehicular transport generates massive urban sprawl and decentralisation away from city centres to vast suburbs. Soleri stated that these suburbs not only obliterated the ecology of the land they spread over, but also obliterated human connections and the ability for personal and collective growth. Where Wilson believed separation from Nature was detrimental to human development, Soleri believed separation from each other to be damaging to humankind. An arcology would be a compact city, bringing people and services back to a centralised location, while the city would be tightly restricted in horizontal growth thus leaving the surrounding natural environment in a state of wilderness. (Soleri 1969; Soleri et al. 2011) In addition to providing a model for energy and resource efficiency, Soleri emphasised the potential for arcologies to provide a unique boundary between built and natural; "*The structure of the habitat is intentionally putting nature at our fingertips"* (Soleri 1993); a point expanded upon by Grierson; "*the drawing together of diverse city functions into mixed use, self-contained arcologies would encourage cultural intensification and social integration within their boundaries, while freeing up the surrounding hinterland to remain natural*" (Grierson 2003). In 1970, Soleri formed the Cosanti Foundation and began construction of Arcosanti, an "urban laboratory" and prototype arcology located in the Arizona desert. Arcosanti aims to explore high density, mixed use design built on a pedestrian scale, while leaving hundreds of acres of surrounding land as natural environment, allowing its residents to be both "city and country dwellers" (Soleri 1993); Fig. 1 shows the Arcosanti site, and some spaces within. At Arcosanti, the boundary between built and natural is immediate; a person can be in untouched Nature moments after leaving the density of the city. Soleri repeatedly stated that he could not, and would not, predict the social dynamic of an arcology: "*What the project wants to avoid is planning the lives of its residents. They are offered a specific grid of environmental resources (the instrument) within which to act and play out their lives (the music)"* (Soleri 1993).

Soleri believed that the social identity of an arcology would and should develop naturally, and the continued inhabitation of Arcosanti gives an opportunity for the social outcomes to be investigated. This work focusses on the effect the unique proximity to the natural environment, through a visual connection, has on the social interactions observed at Arcosanti. Romanticism depicts Nature as peaceful, calming, and introspective; at Arcosanti, then, do strong visual connections with Nature creates spaces for solitude? Or does visual connection to Nature create

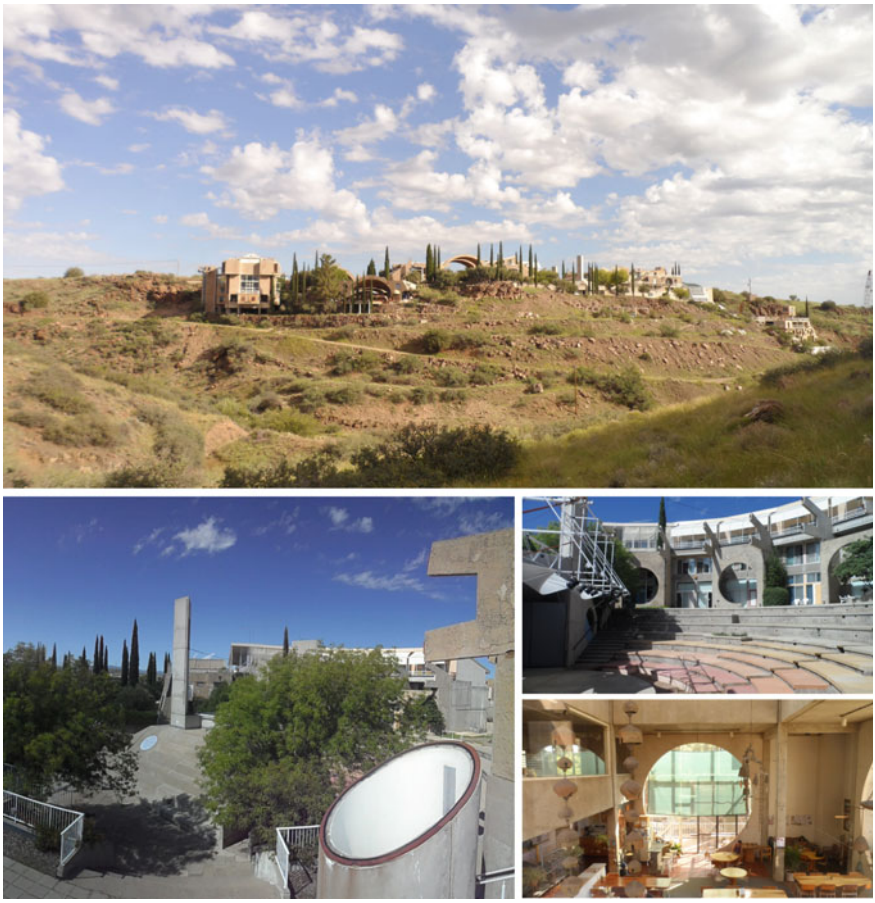

Fig. 1 Images of Arcosanti (all taken by author)

spaces appealing for social events, to gather and enjoy together? It has been suggested that the prevalence of mental illness in cities is a result of social stress and social isolation (Benedictus 2014), therefore understanding the social influence of viewing Nature from within a built environment has clear applicable benefits. This research has developed a methodology to quantify a built space's visual relationship to the natural environment, which has been used alongside Space Syntax analysis and Behavioural Observations in social spaces at Arcosanti to determine whether a visual connection to the natural environment has a significant effect on social interactions, comparative to spatial connectivity. The paper will briefly describe the development of the Space/Nature Syntax, before summarising the findings of its application on 15 social spaces at Arcosanti, and how it could be used to inform future design at Arcosanti.

3 Development of Method

For the purpose of this study, a social space is a space available for use by Arcosanti residents at any time of the day or night. There were 15 such spaces identified which were then analysed according to the methodology to be described. A full description of the development of the Space/Nature Syntax methodology has been accepted for publication in Open House International, Vol. 41, No. 4, in December 2016 (Munro and Grierson 2016).

3.1 Space Syntax

Space Syntax is a tool for analysing spatial configurations and giving statistical value to spaces within buildings and cities, facilitating analysis and planning (Hillier et al. 1976; Hillier and Hanson 1984; Hillier 1999, 2007; Jeong and Ban 2011). Space Syntax determines areas within individual buildings or wider urban environments which have the potential for high social interaction (Campos and Fong 2003) and has been used in this study to analyse the social spaces at Arcosanti to determine which, according to spatial analysis, should be the most and least dynamic. The Space Syntax terminologies to be used henceforth follow:

- N = the number of spaces in a System (Arcosanti)
- Depth (D)—the number of spaces between two spaces. A new Depth is reached when a threshold is crossed.
- Total Depth (TD)—the sum of all spaces at all Depths
- Mean Depth (MD)—the average Depth from the analysed space to all other spaces in the System.

$$MD = \frac{TD}{N-1}$$

- Connectivity (C)—a measure of the number of immediate spaces adjoining the analysed Space.

$$C = \frac{1}{No.\ of\ spaces\ at\ Depth\ 1}$$

- Relative Asymmetry (RA)—a measure of Integration for Systems of comparable size; values are between 0 and 1, where 0 is a strongly integrated space and 1 is a weakly integrated space.

$$RA = \frac{2(MD-1)}{N-2}$$

– Real Relative Asymmetry (RRA)—a measure of Integration for Systems of drastically different sizes. As with the RA, the lower the RRA value, the more accessible a space is; 0.4 to 0.6 is considered to indicate strong integration (Bafna 2003; Hillier and Hanson 1984).

$$RRA = \frac{RA}{D_k}$$

– Dk—average RA of a System of a particular size
– Integration Value (IV)—the inverse of the RRA; therefore the higher the IV, the more Integrated the space is and more likely to be a lively space.

$$\text{IV} = \frac{1}{RRA}$$

(Hillier and Hanson 1984; Klarqvist 1993, Jeong and Ban 2011; Bafna 2003)

3.2 Nature Syntax

The Nature Syntax method is being developed through this research. Nature Syntax analysis produces a Visibility of Nature (VN) value between 0 and 1, where 0 is no visual connection to Nature and 1 is a complete view of Nature. The VN value represents the ratio of the visibility of the natural environment out of the total external visibility from that space, calculated by the equation:

$$Visibility\ of\ Nature\ (VN) = \frac{(Permeability \times Naturalness\ of\ View)}{100}$$

3.2.1 Permeability

Permeability here refers to the area of envelope of a space through which the environment external to the space is visible. A Permeability value between 0 and 1 was calculated for each social space, where 0 is a social space which is completely visually enclosed, while 1 is a social space which is completely visually open to its external environment.

$$Permeability = \frac{\frac{Total\ Permeable\ Surface\ Area}{Total\ Surface\ Area}}{100}$$

3.2.2 Naturalness of View

A land cover plan of Arcosanti was created, assigning land cover according to the well-defined criteria in the U.S. Geological Survey Land Cover Institute National Land Cover Database (NLCD) 2006 (US Department of the Interior and US Geological Survey 2015; Anderson et al. 1976). There are four categories for "Built" land cover, defined by the percentage of coverage which is constructed materials, and one for "Natural", with values from 0 to 1 being assigned to each category. "Natural" land coverage was given a value of 1, with "Developed, High Intensity" receiving a value of 0, and the intermediate classifications given values in intervals of 0.25. Figure 2a shows the land cover plan produced when applying these criteria to the current Arcosanti site, while Fig. 2b shows how each criteria translates to a Naturalness of View value.

In order to determine Naturalness of View from each space, field of vision studies were carried out for each of the 15 social spaces. The foveal and peripheral fields of vision (Gehl et al. 2006) from a centre point in the space were drawn for each direction and overlaid onto the Arcosanti land cover site plan. The type of land cover which was predominantly covered by the field of vision was taken to be the type of land cover for that direction, and the associated value between 0 and 1 was documented. This process was repeated in section to take into account the three-dimensionality of both the structures and Arcosanti site. Finally, the values documented were confirmed visually at the Arcosanti site by the researcher.

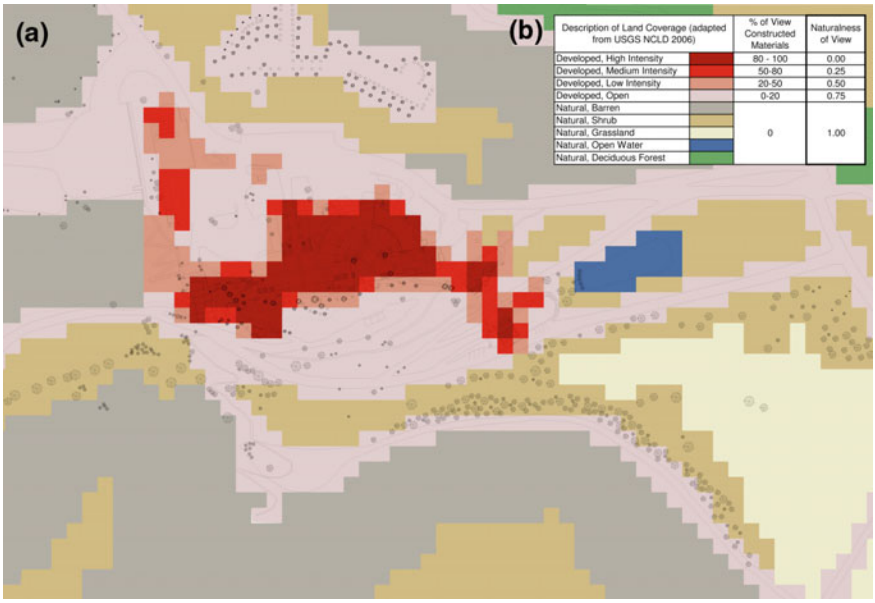

Fig. 2 **a** NCLD phase I Arcosanti plan and **b** adapted NCLD legend

The final value for Naturalness of View for each space is the sum of the value for the five directions, divided by 5.

The Permeability and Naturalness of View figures for each space were then used to find the Visibility of Nature value using the previously stated formula.

3.3 Behavioural Observations

An observation method was developed through background research of methods commonly used in environmental psychology (Thwaites 2007; Golicnik and Ward Thompson 2010; Costa 2011; Gehl 1987, 2010, 2011; Liu and Sibley 2004; Moirongo 2002; Simpson 2011; Zhang and Lawson 2009). A total of 107 observations were carried out at Arcosanti over 3 months, noting the following behaviours:

- Type of Space Use
  - "Active"—space being directly used for an activity; the end destination.
  - "Inactive"—space being used as a through route.
- Level of Planning
  - "Planned"—a predetermined activity at an agreed time e.g. an arranged event; a work task; a meeting; a guided tour group.
  - "Unplanned"—a spontaneous activity e.g. informal/impromptu social or work interactions; non-essential use as through route.
- Visual Interaction with Natural Environment
  - Behaviour which facilitates a visual interaction with Nature e.g. looking out window; body position; pointing; drawing; photographing.

3.4 Correlation Analysis

Finally, correlations were calculated between the results of the Space Syntax, Nature Syntax and Behavioural Observation studies which allowed an initial understanding of where the data is suggesting relationships between the variants.

4 Limitations

The methodology is the result of research work drawing together existing methods in a novel way; therefore, as with any research of this kind, there remains areas for further development.

The methodology eventually seeks to explore how humans' sensory experience of Nature affects social interaction; therefore the research is limited by its focus on solely visual connectivity. This focus was the most established in previous sense-environment studies however future work should explore all senses to fully understand the human experience created by proximity to Nature.

Similarly, the method currently lacks qualitative data on the emotional effect of proximity to Nature; the quantitative data gathered suggests links between spatial connectivity, connectivity to Nature, and social interactions, but only a qualitative study focussed on the thoughts and feelings of the inhabitants would confirm cause-and-effect relationships.

Finally, repeat applications of the methodology at sites other than Arcosanti would enhance the connections found and further develop the Space/Nature Syntax methodology.

5 Results

The research applied Space/Nature Syntax to 3 stages of construction at Arcosanti to display the applicability of the method as an analysis and design tool. Figure 3 shows the Arcosanti site as currently constructed; and planned construction for Phases II & III.

Fig. 3 Phases I, II and III Site Plan

- Phase I—Arcosanti site as currently built; Space Syntax, Nature Syntax and Behavioural Observations were carried out based on existing conditions.
- Phase II—Short term construction; Space Syntax and Nature Syntax was recalculated following the completion of immediate construction goals. Using the values for Behaviour observed in Phase I, and correlations which suggested statistically significant relationships, Projected Usage figures were calculated, providing a suggestion of how the short term construction goals could alter how the existing social spaces would be used.
- Phase III—Long term construction; the construction of a number of new buildings, most of which would be located south and west of the existing construction. As with Phase II, the Space Syntax and Nature Syntax process was repeated for each of the existing social spaces before Projected Usages figures were suggested.

The changes to spatial connectivity and visibility of Nature of the existing spaces were possible to calculate with reasonable accuracy as the Cosanti Foundation's construction plans for both Phases II and III were developed enough to allow this. The plans were not, however, detailed enough for any new social spaces to be considered with the exception of one in Phase II: predominantly as there is a lack of information on the intended function of each new space. Therefore, it is essential to acknowledge that where the construction of a new building may alter the spatial connectivity or visibility of Nature of an existing space, it could certainly do so while providing a new social space with an equivalent spatial or visual connection.

5.1 Phase I

The table in Fig. 4 shows the results of the Space Syntax analysis, with the 15 social spaces ordered from lowest to highest RRA; most to least spatially connected. In Phase I the social space with the lowest RRA, and therefore the highest spatial connectivity, was the Vaults at 0.7523, while the highest RRA returned and therefore least spatially connected was the Office at 1.5707. Figure 5 displays the VN values for each social space for Phase I, ordered from highest VN to lowest. The social space with the highest VN value, and thus highest visual connection to Nature, was the East Crescent Roof with a value of 0.69, while both the Community Room and the Library/Rec Room had VN values of 0. The initial analysis of Phase I took these 5 spaces, as the extremes of the results, and examined how they were observed in the Behavioural studies. Figure 6 shows the results of these observations, in both actual numbers of each activity in each space, and the percentage share of each activity in each space over all observations.

As expected, the East Crescent Roof was where most people were observed displaying a Visual Interaction with the Natural Environment, with 84 % of all such interaction occurring in this space. The Community Room and Library/Rec Room both had 0 % of Visual Interaction with Natural Environment, again expected as

PHASE I
ARCOSANTI SITE AS EXISTING
ORDERED BY LOWEST TO HIGHEST RRA (MOST TO LEAST SPATIALLY CONNECTED)

Social Space	Total Depth	Mean Depth	Connectivity	RA	**RRA**	Integration Value
Vaults	1125	5.0	0.17	0.0354	**0.7523**	1.3292
Community Room	1161	5.1	0.20	0.0368	**0.7824**	1.2780
Library/Rec Room	1367	6.0	0.50	0.0449	**0.9548**	1.0473
Amphitheatre Seating	1403	6.2	0.17	0.0463	**0.9850**	1.0153
Ceramics	1519	6.7	0.33	0.0509	**1.0820**	0.9242
Sky Theatre	1522	6.7	0.50	0.0510	**1.0845**	0.9220
Vault Roof	1580	7.0	0.50	0.0533	**1.1331**	0.8826
Roof Patio	1587	7.0	0.33	0.0535	**1.1389**	0.8780
Amphitheatre Stage	1664	7.4	0.20	0.0566	**1.2034**	0.8310
Café	1676	7.4	0.20	0.0570	**1.2134**	0.8241
Music Centre	1684	7.5	0.33	0.0573	**1.2201**	0.8196
EC Roof	1771	7.8	1.00	0.0608	**1.2929**	0.7734
Classroom	1828	8.1	1.00	0.0630	**1.3406**	0.7459
Red Room	2063	9.1	0.33	0.0723	**1.5373**	0.6505
Office	2103	9.3	0.25	0.0738	**1.5707**	0.6366
Averages	1604	7.1	0.40	0.0542	**1.1528**	0.9039

Fig. 4 Phase I RRA results

PHASE I
ARCOSANTI SITE AS EXISTING
ORDERED FROM HIGHEST TO LOWEST VN (MOST TO LEAST VISIBILITY OF NATURE)

Social Space	Permeability (%)							Naturalness of View						**Visibility of Nature (VN) Value**
	N	E	S	W	ABOVE	Total	Ratio							
	Open	Open	Open	Open	Open	Open		N	E	S	W	ABOVE	T	
East Crescent Roof	91	87	90	90	100	91.6	0.92	0.75	1	1	0	1	0.75	**0.69**
Vault Roof	100	100	100	100	100	100	1.00	0.5	0	1	0	1	0.5	**0.50**
Sky Theatre	82	100	100	100	100	96.4	0.96	0	0	1	0	1	0.4	**0.39**
Roof Patio	95	82	91	90	100	91.6	0.92	0.5	0	0	0	1	0.3	**0.27**
Amphitheatre Seating	100	100	100	100	100	100	1.00	0	0	0	0	1	0.2	**0.20**
Ceramics	12	65	100	65	74	63.2	0.63	0	0	0.25	0	1	0.25	**0.16**
Vaults	42	30	100	33	32	47.4	0.47	0	0	0.5	0	1	0.3	**0.14**
Café	0	25	27	33	16	20.2	0.20	0	0.25	0.75	0.75	1	0.55	**0.11**
Amphitheatre Stage	100	46	42	43	38	53.8	0.54	0	0	0	0	1	0.2	**0.11**
Red Room	15	19	28	12	6	16	0.16	0.5	0.5	0.75	0	0.5	0.45	**0.07**
Office	0	33	26	0	9	13.6	0.14	0	0.5	0.75	0	1	0.45	**0.06**
Music Centre	53	0	64	0	0	23.4	0.23	0	0	0.75	0	0	0.15	**0.04**
Classroom	0	30	0	29	0	11.8	0.12	0	0.75	0	0	0	0.15	**0.02**
Community Room	0	54	0	0	0	10.8	0.11	0	0	0	0	0	0	**0.00**
Library/Rec Room	0	0	0	0	0	0	0.00	0	0	0	0	0	0	**0.00**
AVG	46	51	58	46	45	49.3	0.49	0.2	0.2	0.5	0.1	0.7	0.31	**0.18**

Fig. 5 Phase I VN results

they have no visual relationship to Nature. The East Crescent Roof was generally used more regularly than the Community Room and Library/Rec Room, with 18.7 % of Total People over all observations, compared to 8.1 and 0.8 %.

An interesting outcome from the observational data is that the East Crescent Roof experienced a contrasting type of social interaction from both the Community Room and the Library/Rec Room. The East Crescent Roof saw 23.7 % of total Active use but 0 % of Inactive, compared to the Community Room which only saw 4.8 % of

PHASE I
BEHAVIOURAL OBSERVATIONS, AS CARRIED OUT ON SITE AT ARCOSANTI
ORDERED ALPHABETICALLY

			SPACE															
			Amphitheatre Seating	Amphitheatre Stage	Cafe	Ceramics	Classroom	Community Room	East Crescent Roof	Library/Rec Room	Music Centre	Office	Red Room	Roof Patio	Sky Theatre	Vaults	Vaults Roof	TOTAL PEOPLE
No. of People	Type of Use	Active	102	4	169	80	27	33	162	4	9	32	2	8	1	49	2	684
		Inactive	52	3	16	31	0	37	0	3	0	11	0	0	11	20	0	184
	Level of Planning	Planned	114	4	142	108	27	33	157	0	8	39	2	0	0	54	0	688
		Unplanned	40	3	43	3	0	37	5	7	1	4	0	8	12	15	2	180
	Visual Interaction with Nature		0	1	11	4	0	0	110	0	0	0	0	0	1	2	2	131
	TOTAL PEOPLE		154	7	185	111	27	70	162	7	9	43	2	8	12	69	2	868
% Share of Total	Type of Use	Active	14.9%	0.6%	24.7%	11.7%	3.9%	4.8%	23.7%	0.6%	1.3%	4.7%	0.3%	1.2%	0.1%	7.2%	0.3%	100.0%
		Inactive	28.3%	1.6%	8.7%	16.8%	0.0%	20.1%	0.0%	1.6%	0.0%	6.0%	0.0%	0.0%	6.0%	10.9%	0.0%	100.0%
	Level of Planning	Planned	16.6%	0.6%	20.6%	15.7%	3.9%	4.8%	22.8%	0.0%	1.2%	5.7%	0.3%	0.0%	0.0%	7.8%	0.0%	100.0%
		Unplanned	22.2%	1.7%	23.9%	1.7%	0.0%	20.6%	2.8%	3.9%	0.6%	2.2%	0.0%	4.4%	6.7%	8.3%	1.1%	100.0%
	Visual Interaction with Nature		0.0%	0.8%	8.4%	3.1%	0.0%	0.0%	84.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.8%	1.5%	1.5%	100.0%
	Total People		17.7%	0.8%	21.3%	12.8%	3.1%	8.1%	18.7%	0.8%	1.0%	5.0%	0.2%	0.9%	1.4%	7.9%	0.2%	100.0%

Fig. 6 Phase I behavioural observation results

Active Use, but 20.1 % of Inactive use. These differences were less significant for the Library/Rec Room, but were still greater for Inactive (1.6 %) than Active (0.6 %). Additionally, the East Crescent Roof was the location for a higher percentage of all Planned Use at 22.8 % when compared to Unplanned Use at 2.8 %, again contrasting with the Community Room which had only 4.8 % of Planned Use, but 20.6 % of Unplanned Use, and the Library/Rec Room which saw 0 % of Planned Use but 3.9 % of Unplanned Use. This would seem to suggest that a space which has a high visual connection to Nature is more likely to see Active, Planned use, while a low visual connection to Nature promotes Inactive, Unplanned use.

The Behavioural Observations show that the differences in activity between the Vaults and the Office, the most and least spatially connected spaces, were not as significant when compared with the differences for the highest and lowest values of the VN value; the Vaults had a 7.9 % share of Total People, while the Office's share was 5 %. These slight differences are consistent throughout all categories of activity observed in the Observation studies. The Vaults has only marginally more a percentage of Total Active Use than the Office (7.2 % compared with 4.7 %); Total Inactive Use (10.9–6 %); Planned Use (7.8–5.7 %); and Unplanned Use (8.3–2.2 %).

The discussions of individual spaces suggests a relationship between visibility of a natural environment and social interactions and also suggest that, at Arcosanti, the spatial integration of a space is not the strongly influence on social interaction. The spaces which result at extremes of the Space Syntax analysis do not display as significant a distinction in any type of social interaction as those which are at the extremes of the Nature Syntax results, suggesting that the visibility of Nature from a social space has a more significant influence on the social interaction within that space. While this chapter discusses only 5 spaces, these initial findings seem to be somewhat supported by the correlations produced for all variables. Figure 7 shows statistically significant correlations, including those between RRA value, and Inactive Use and Unplanned Use, supporting the patterns in the discussion. The discussion also suggested relationships between VN value and Active Use and

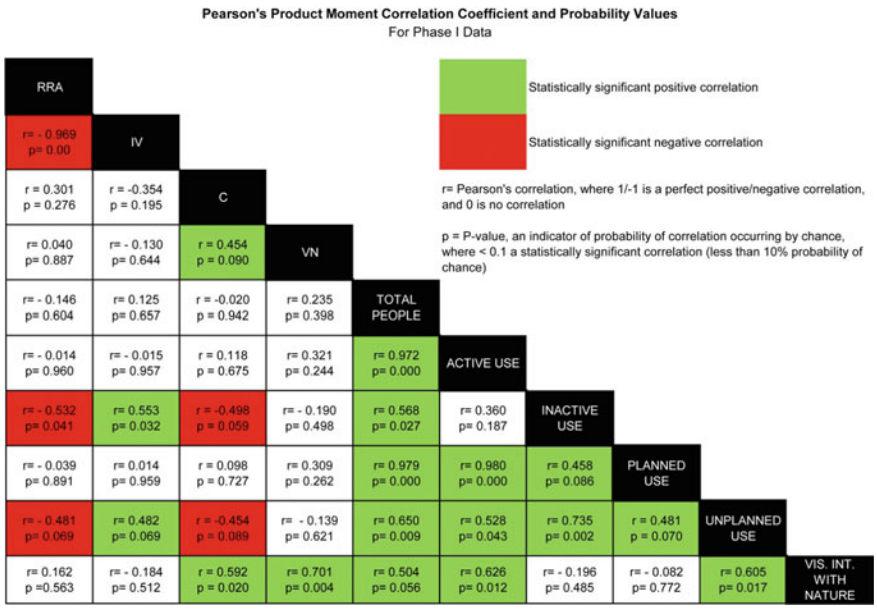

Fig. 7 Phase I correlation matrix

Planned Use, but these correlate less significantly than the exploration of individual spaces implied. Overall, the discussion of individual spaces and the correlation data seems to support that the RRA is influential in determining different type of social interaction, but the VN value's influence needs further clarification.

6 Application

This section will demonstrate how the methodology can be used to calculate how future construction at the Arcosanti site could influence changes in the social interactions experienced in each of the existing social spaces.

6.1 Calculated Changes in RRA and VN

In Phase II the East Crescent Roof would be constructed on, with apartments replacing the existing social space. The empty "keystone" lot adjacent to the East Crescent Roof would have an indoor theatre constructed, which would create a new social space, named the Keystone Courtyard and included in the Phase II analysis. The new theatre also removes a potential route across the Arcosanti site.

PHASE II
SHORT TERM CONSTRUCTION
ORDERED BY LOWEST TO HIGHEST RRA (MOST TO LEAST SPATIALLY CONNECTED)

Social Space	Total Depth	Mean Depth	Connectivity	RA	RRA	Integration Value
Vaults	1276	5.2	0.17	0.0345	**0.7839**	1.2756
Community Room	1293	5.3	0.20	0.0351	**0.7969**	1.2549
Keystone Courtyard*	1528	6.2	0.50	0.0429	**0.9755**	1.0251
Library/Rec Room	1550	6.3	0.50	0.0437	**0.9923**	1.0078
Amphitheatre Seating	1562	6.4	0.17	0.0441	**1.0014**	0.9986
Ceramics	1732	7.1	0.33	0.0497	**1.1307**	0.8844
Sky Theatre	1745	7.1	0.50	0.0502	**1.1405**	0.8768
Roof Patio	1759	7.2	0.33	0.0507	**1.1512**	0.8687
Vault Roof	1799	7.3	0.50	0.0520	**1.1816**	0.8463
Amphitheatre Stage	1859	7.6	0.20	0.0540	**1.2272**	0.8148
EC Roof*	1875	7.7	0.20	0.0545	**1.2394**	0.8068
Café	1912	7.8	0.20	0.0558	**1.2675**	0.7889
Music Centre	1937	7.9	0.33	0.0566	**1.2865**	0.7773
Classroom	1992	8.1	1.00	0.0584	**1.3284**	0.7528
Red Room	2353	9.6	0.33	0.0705	**1.6028**	0.6239
Office	2372	9.7	0.25	0.0712	**1.6173**	0.6183
Averages	1745	7.1	0.36	0.0502	**1.1404**	0.9069

*New Social Space Created by Construction
*Existing Social Space Removed by Construction

Fig. 8 Phase II RRA results

The table in Fig. 8 shows the recalculated RRA values following Phase II construction, and highlights new spaces created and existing spaces lost. The new construction would alter very little spatial connectivity, with the Vaults and Office remaining most and least spatially connected respectively.

Again, the table in Fig. 9 shows the recalculated values and changes to spaces following Phase II construction, this time for the VN values. The VN values for Phase II change much more significantly than the RRA values. The East Crescent Roof was previously the social space with the highest visual connection to Nature; Phase II construction now eliminates it as a social space, with the Vaults Roof replacing it as the space with the highest VN. Additionally, the construction of a permanent canopy above the Amphitheatre eliminates any visibility of the sky from the Amphitheatre's two social spaces, reducing both their VN values to 0.00.

The changes in spatial connectivity by Phase III are much more significant than in Phase II; these changes in RRA can be seen in Fig. 10. As a whole, the spatial connectivity of the Arcosanti site considerably improves, with the average RRA calculated at 0.8567, and the most connected space returning an RRA of 0.5032, a value in the range considered a very strong connection. The social space which would be most connected in Phase III is Ceramics, while the Classroom becomes the least connected, at 1.1796. The Vaults, previously the most spatially connected space in both Phases I and II, is now approximately mid table with an RRA of 0.7531.

PHASE II
SHORT TERM CONSTRUCTION
ORDERED BY HIGHEST TO LOWEST VN (MOST TO LEAST VISIBILITY OF NATURE)

Social Space	Permeability (%)							Naturalness of View						Visibility of Nature (VN) Value
	N	E	S	W	ABOVE	Total	Ratio	N	E	S	W	ABOVE	T	
	Open	Open	Open	Open	Open	Open								
Vault Roof	100	100	100	100	100	100	1.00	0.5	0	1	0	1	0.5	**0.50**
Sky Theatre	82	100	100	100	100	96.4	0.96	0	0	1	0	1	0.4	**0.39**
Roof Patio	95	82	91	90	100	91.6	0.92	0.5	0	0	0	1	0.3	**0.27**
Ceramics	12	65	100	65	74	63.2	0.63	0	0	0.25	0	1	0.25	**0.16**
Vaults	42	30	100	33	32	47.4	0.47	0	0	0.5	0	1	0.3	**0.14**
Café	0	25	27	33	16	20.2	0.20	0	0.25	0.75	0.75	1	0.55	**0.11**
Red Room	15	19	28	12	6	16	0.16	0.5	0.5	0.75	0	0.5	0.45	**0.07**
Office	0	33	26	0	9	13.6	0.14	0	0.5	0.75	0	1	0.45	**0.06**
Music Centre	53	0	64	0	0	23.4	0.23	0	0	0.75	0	0	0.15	**0.04**
Classroom	0	30	0	29	0	11.8	0.12	0	0.75	0	0	0	0.15	**0.02**
Amphitheatre Seating	100	100	100	100	0	80	0.80	0	0	0	0	0	0	**0.00**
Amphitheatre Stage	100	46	42	43	0	46.2	0.46	0	0	0	0	0	0	**0.00**
Community Room	0	54	0	0	0	10.8	0.11	0	0	0	0	0	0	**0.00**
EC as Planned	91	79	65	79	31	69	0.69	0	0	0	0	0	0	**0.00**
Keystone Courtyard	25	0	100	0	0	25	0.25	0	0	0	0	0	0	**0.00**
Library/Rec Room	0	0	0	0	0	0	0.00	0	0	0	0	0	0	**0.00**
AVG	45	50	57	46	32	46.022	0.46	0.1	0.2	0.4	0.0	0.5	0.24	**0.14**

Fig. 9 Phase II VN results

PHASE III
LONG TERM CONSTRUCTION
ORDERED BY LOWEST TO HIGHEST RRA (MOST TO LEAST SPATIALLY CONNECTED

Social Space	Total Depth	Mean Depth	Connectivity	RA	RRA	Integration Value
Ceramics	5298	6.5	0.33	0.0136	**0.5032**	1.9871
Community Room	6015	7.4	0.20	0.0158	**0.5837**	1.7132
Café	6074	7.5	0.20	0.0159	**0.5903**	1.6940
Vault Roof	6574	8.1	0.50	0.0175	**0.6464**	1.5470
Roof Patio	7454	9.2	0.33	0.0201	**0.7452**	1.3420
Vaults	7525	9.3	0.17	0.0203	**0.7531**	1.3278
Library/Rec Room	7721	9.5	0.50	0.0209	**0.7751**	1.2901
Music Centre	8341	10.3	0.33	0.0228	**0.8447**	1.1839
Amphitheatre Stage	8796	10.8	0.20	0.0242	**0.8957**	1.1164
Sky Theatre	9029	11.1	0.50	0.0249	**0.9219**	1.0847
Amphitheatre Seating	9134	11.2	0.17	0.0252	**0.9337**	1.0710
Keystone Courtyard	9591	11.8	0.50	0.0266	**0.9850**	1.0153
Red Room	10168	12.5	0.33	0.0283	**1.0497**	0.9527
Office	11026	13.6	0.25	0.0309	**1.1460**	0.8726
EC Roof	11096	13.6	0.20	0.0312	**1.1538**	0.8667
Classroom	11326	13.9	1.00	0.0319	**1.1796**	0.8477
Averages	8448	10.4	0.36	0.0231	**0.8567**	1.2445

Fig. 10 Phase III RRA results

Phase III construction alters the VN value significantly for the Music Centre as seen in the table in Fig. 11, completely eliminating any visual relationship with the natural environment, from a VN value of 0.04. The Vaults Roof remains the social space with the highest visibility of Nature with its VN value remaining 0.50. By Phase III, 7 of the 16 existing social spaces would have no visual relationship with

PHASE III
LONG TERM CONSTRUCTION
ORDERED BY HIGHEST TO LOWEST VN (MOST TO LEAST VISIBILITY OF NATURE)

Social Space	Permeability (%)							Naturalness of View						Visibility of Nature (VN) Value
	N	E	S	W	ABOVE	Total	Ratio	N	E	S	W	ABOVE	T	
	Open	Open	Open	Open	Open	Open								
Vault Roof	100	100	100	100	100	100	1.00	0.75	0	0.75	0	1	0.5	**0.50**
Sky Theatre	82	100	100	100	100	96.4	0.96	0	0	0.75	0	1	0.35	**0.34**
Roof Patio	95	82	91	90	100	91.6	0.92	0.5	0	0	0	1	0.3	**0.27**
Ceramics	12	65	100	65	74	63.2	0.63	0	0	0	0	1	0.2	**0.13**
Vaults	42	30	100	33	32	47.4	0.47	0	0	0	0	1	0.2	**0.09**
Café	0	25	27	33	16	20.2	0.20	0	0	1	0	1	0.4	**0.08**
Red Room	15	19	28	12	6	16	0.16	0.5	0.5	0	0	0.5	0.3	**0.05**
Office	0	33	26	0	9	13.6	0.14	0	0.5	0	0	1	0.3	**0.04**
Classroom	0	30	0	29	0	11.8	0.12	0	0.75	0	0	0	0.15	**0.02**
Amphitheatre Seating	100	100	100	100	0	80	0.80	0	0	0	0	0	0	**0.00**
Amphitheatre Stage	100	46	42	43	0	46.2	0.46	0	0	0	0	0	0	**0.00**
Community Room	0	54	0	0	0	10.8	0.11	0	0	0	0	0	0	**0.00**
EC Roof	91	79	65	79	31	69	0.69	0	0	0	0	0	0	**0.00**
Keystone Courtyard	25	0	100	0	0	25	0.25	0	0	0	0	0	0	**0.00**
Library/Rec Room	0	0	0	0	0	0	0.00	0	0	0	0	0	0	**0.00**
Music Centre	53	0	64	0	0	23.4	0.23	0	0	0	0	0	0	**0.00**
AVG	45	50	57	46	32	46.022	0.46	0.1	0.2	0.1	0.0	0.5	0.18	**0.11**

Fig. 11 Phase III VN results

the natural environment at all. The majority of Phase III construction is planned for the South slope of the Arcosanti site, reflected in the significant decrease in average Naturalness of View figures for South facing views; this was 0.5 in Phase I, and 0.1 by Phase III.

6.2 Projected Changes in Social Interactions

Using the statistically significant correlations produced by the analysis of Phase I, potential changes in social interaction for Phases II and III could be projected based on the recalculated space and Nature Syntax values for the existing social spaces. To ensure accurate comparisons, the correlation equations were first applied to the original Space and Nature Syntax values calculated in Phase I to produce hypothetical values for each type of social interaction, thus ensuring the only variants were the new RRA and VN values. The changes in the percentage of each type of social interaction, for each social space and across each Phase, were then calculated showing how alterations in RRA and VN could affect social interaction.

The graph in Fig. 12 shows the largest projected decrease in Total People between Phase I and Phase III for the Amphitheatre Seating where a reduction of 2.6 % share of activity was projected. The largest increase in Total People was projected for Ceramics, with an overall increase of 0.3 %. The Vaults would also see a significant decrease in share of Total People as it becomes a less central space, with an overall decrease of 1.5 %.

There was an 11 and 7 % decrease of Visual Interaction with the Natural Environment projected in the Amphitheatre Seating and Amphitheatre Stage spaces by Phase III, again due to the removal of any visibility of Nature; Fig. 13 shows the

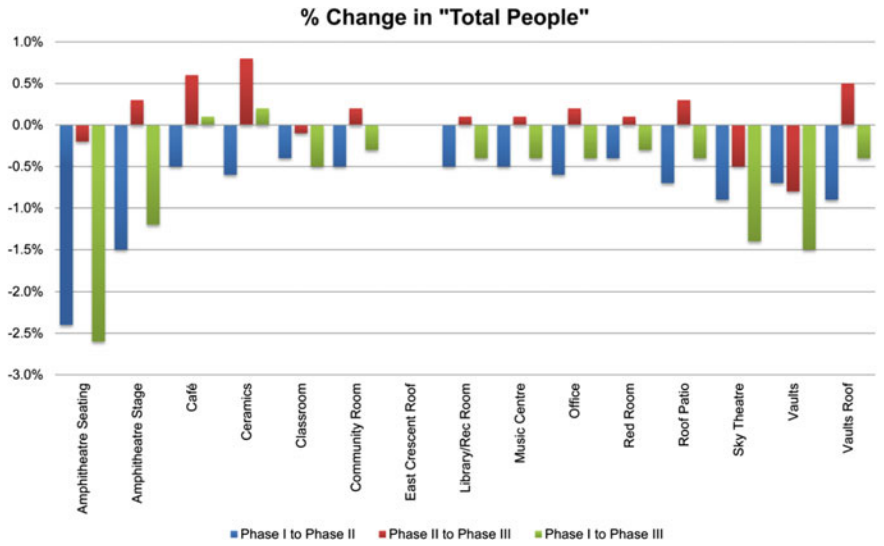

Fig. 12 Change in total people from phase I to phase III

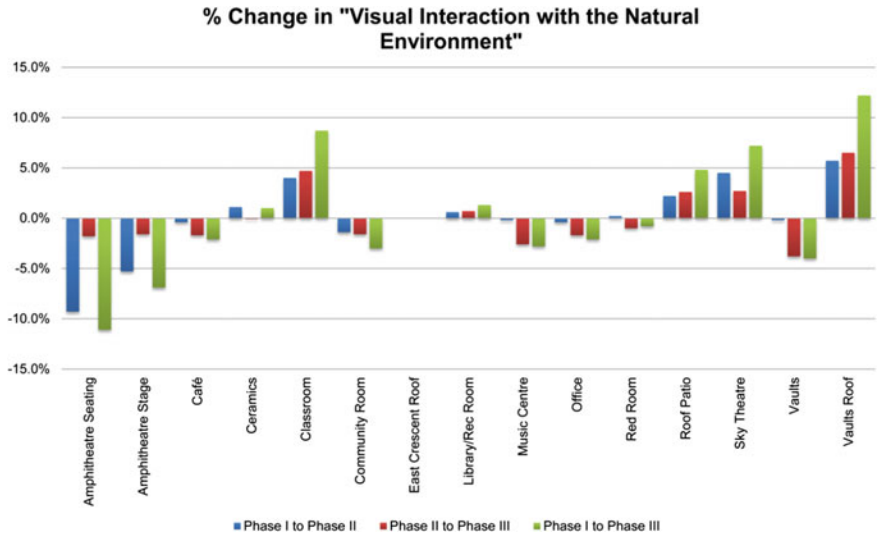

Fig. 13 Change in visual interaction with the natural environment from phase I to phase III

projected changes in this activity type. The elimination of the East Crescent Roof as a key space in VN values is reflected in the increase in share of Visual Interaction with the Natural Environment for the remaining spaces with a high VN value; the Vaults Roof (+12 %), Sky Theatre (+7 %), and Roof Patio (+4.5 %).

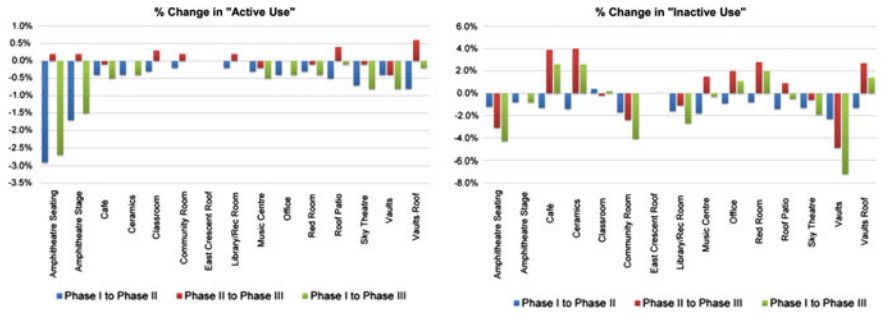

Fig. 14 Change in active and inactive use for phase I to phase III

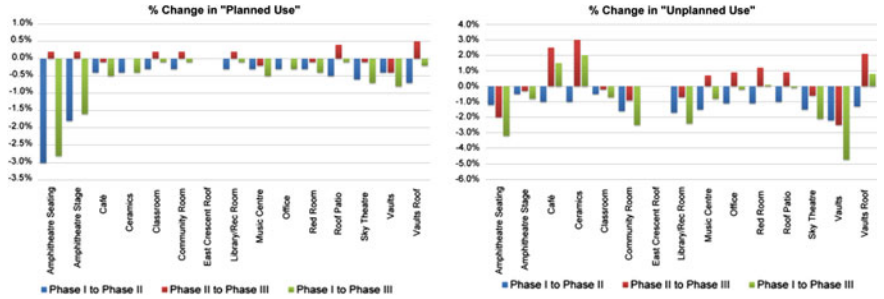

Fig. 15 Change in planned and unplanned use for phase I to phase III

Projected changes for the different types of social interaction were also calculated. Figure 14 shows how Active and Inactive Use in the social spaces could alter, while Fig. 15 shows projected alterations in Planned and Unplanned Use. The correlation between RRA, IV and C, and Inactive Use produces a significant change in % share for Ceramics as it becomes the most spatially connected space, increasing by 2.5 % between Phase I and III. The Vaults, which had the highest RRA in Phases I and II but fell to mid-table by Phase III, could see its Inactive Use reduced by 7 % from Phase I to Phase III.

Similar projected changes in % share could also be seen for Unplanned Use which was correlated significantly with measures of spatial connectivity, where the Vaults could see a reduction of 4.5 % by Phase III. Ceramics could see an overall increase of 2 % share between Phase I and III as it becomes the most connected space.

7 Conclusion

Discussion of key spaces during Phase I seem to support that visibility of Nature, in addition to spatial connectivity, has a significant role in influencing how social interactions occur, and that the two measures may each inform different types of social interactions. The correlations produced from all data, however, don't present this as strongly; although RRA is significantly correlated with Inactive and Unplanned Use, VN is correlated only with Visual Interaction with the Natural Environment. Future work will therefore be focussed on an additional visit to the Arcosanti site for the purpose of additional Behavioural Observations, in order to produce more data to further enhance the statistical relationship between spatial connectivity, visibility of Nature and social interactions.

It is important to note that correlation studies do not show cause and effect, merely the existence of a statistically relationship. Thus it cannot be categorically said that, for example, an increase in spatial connectivity definitely causes an increase in Inactive Use; only that a relationship exists between them. It is therefore prudent that the work continues to progress by supporting the statistical correlations with qualitative evidence as to how spatial connectivity and visibility of Nature affect how people interact socially in these spaces at Arcosanti. Initial work has been undertaken to develop a method to do this, focussing around questionnaires using established environmental psychology methods of assessing the emotional connection between humans and Nature.

This paper has briefly demonstrated how the Space/Nature Syntax methodology could be used as an analysis tool when informing future design at the Arcosanti site specifically. Nevertheless, the process described here is one which is repeatable, and importantly, scalable to both individual buildings or entire sections of cities, therefore even in its current rudimentary state it has potential for application as a design and analysis tool within existing and planned urban social spaces. It must again be stressed that this paper represents a first step towards a fully developed Space/Nature Syntax, and the potentials for future research building on this work cover many academic disciplines. Within the field of architecture and urban design, repeated application of the methodology in different sites, in different cities, will both test and validate the overall applicability of the methodology. Arcosanti is unique in that it is a dense, populated structure closely surrounded by pure untouched Nature; urban settlements across the world do not generally have this clear a boundary between built and natural. However, the method proposed here for assigning Naturalness of View accounts for this; urban greenery in the form of parks, roof top gardens, street lined trees or even green walls could all be categorised and assessed using this method. The academic development of the Space/Nature Syntax is not limited to design based subjects; as mentioned previously, there is a real need for a qualitative evidence to support the quantitative presented here. Therefore there are opportunities in sociology and environmental psychology to build upon these foundations and understand how this statistical approach translates to in-depth human behaviour and thinking. Finally, there could

be academic applications of the Space/Nature Syntax in the field of mathematics and statistics; the statistical analysis carried out in this paper is basic, and the data gathered here and in subsequent applications of the method could be explored in greater depth with more advanced statistical knowledge.

The research work on which this paper is based is addressing an intersection between built environment, natural environment, and social interaction which will be all the more relevant as urbanisation continues. Increasingly people are migrating to the city in search of its potential social, economic and cultural benefits, but are sacrificing a generally accepted innate need for connection with Nature and potentially placing themselves at higher risk of the mental health illnesses associated with both city living and withdrawal from Nature. A truly interdisciplinary methodology, the Space/Nature Syntax considers how to maximise the benefits of both Nature and social space within an urban environment, and could prove to be an important research, design and analysis tool for cities in the future.

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Author Biographies

Karen Munro is a PhD researcher in the Department of Architecture at the University of Strathclyde, Glasgow, Scotland. She graduated with a BSc (Hons) in Architectural Studies in 2010, and MRes Building Design and Management for Sustainability in 2012, both also from the University of Strathclyde. Since 2013 she has worked alongside Dr David Grierson in developing the collaborative partnership between the University of Strathclyde and the Cosanti Foundation in Arizona, USA, through both her PhD and the establishment of an MSc Sustainable Engineering: Architecture and Ecology degree which is delivered jointly between the University and the Cosanti Foundation, in Glasgow and Arizona. Her main research interest is sustainable development in cities, particularly around the study of public space, environmental-related behaviour, and connections between built and natural environments. Throughout her time at the University of Strathclyde, she has assisted in conference and event organisation, been elected student representative, and contributed to the delivery and assessment of Sustainability classes. She has also worked with staff and students from across the Architecture department on an application to obtain the Athena Swan Bronze Award.

Dr David Grierson is Deputy Head of the Department of Architecture at the University of Strathclyde Glasgow. He also chairs Strathclyde's Graduate School of Engineering, and has directed the Faculty-wide postgraduate programme in Sustainable Engineering since 2004. He is a registered architect (ARB) and a Fellow of the Higher Education Academy (FHEAD). Dr Grierson has been external examiner at University College London (UCL) and holds current examiner appointments at Sheffield Hallam University, in England, and Queen's University Belfast in Northern Ireland. Dr Grierson's research interests include sustainable architecture and ecological design. His subject expertise in sustainability has led to a large number of peer-reviewed international publications and to his recent appointments as visiting professor at Universities in Doha in Qatar, and Rome and Florence in Italy. In 2013 Dr Grierson was appointed as the first visiting professor at Arcosanti in Arizona, USA, and joined the Steering Committee of the Cosanti Foundation, USA, overseeing the strategic plan for the development of an experimental prototype sustainable city in the Arizona desert in the United States.

The Effects of Higher Education in Economics, Law and Political Science on Perceptions of Responsibility and Sustainability

Niklas Harring, Cecilia Lundholm and Tomas Torbjörnsson

Abstract

Problems of environmental degradation are often conceptualized in terms of collective action dilemmas, and imply an increased demand for coordination and steering by public authorities. Social science is struggling with understanding how attitudes to collective action dilemmas and state intervention actually are formed. In the literature on environmental attitude formation, education is often claimed to be an important factor. It is argued for example that people with university degrees develop certain values essential for beliefs about personal responsibility and concern for the environment. Still there are a number of questions unanswered. For example, we know little about the effects of different educational programs. In this study we test the hypotheses by using a unique longitudinal data set based on surveys distributed to students in economics, law, and political science at seven universities in Sweden. Our results show a slight decrease in ascribed personal responsibility for environmental protection among the students after one semester. Instead, students ascribe an increased responsibility to various institutions and actors.

N. Harring (✉)
Department of Political Science, University of Gothenburg,
Box 711, 405 30 Gothenburg, Sweden
e-mail: niklas.harring@pol.gu.se

C. Lundholm · T. Torbjörnsson
Department of Humanities and Social Science Education,
Stockholm University, 106 91 Stockholm, Sweden
e-mail: cecilia.lundholm@hsd.su.se

T. Torbjörnsson
e-mail: tomas.torbjornsson@hsd.su.se

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1 Introduction

Several of the most pressing environmental problems (e.g. climate-change, ocean acidification, and chemical pollution) are argued to be based on individual consumption choices and hence could be described in terms of large-scale collective action dilemmas, where individual rationality is at odds with collective rationality. As individual consumers we receive the benefits of our consumption while the costs are shared by the collective, in terms of environmental degradation (Dawes 1980; Dietz et al. 2002; Hardin 1968; Olson 1965). If people do not make sacrifices voluntarily, the intervention of a third actor, which in most cases would be the government, is necessary in order to achieve large-scale collective action (Mansbridge 2014). But such intervention is unlikely to be successful if people do not accept it. Hence for a sustainable trajectory, individuals need to be both prepared to make individual sacrifices for the environment, and/or be willing to accept and comply with governmental policy. How such sustainability norms can be created and shaped is therefore one of the most important questions that we face today.

Education is often put forth as a possible solution and a route to a more sustainable trajectory (United Nations 2005). Within the educational system this is a concern for everyone, from pre-school to higher education institutions. How education for sustainable development or education in general has an effect on environmental support is however disputed. In this report we focus on higher education where research show mixed results. Many studies claim that people with higher education (or more years of schooling) are more likely to show environmental support by choosing more environmentally sound consumer products, express environmental concern, and support environmentalism in general (Dietz et al. 1998; Franzen and Vogl 2013; Jones and Dunlap 1992; Klineberg et al. 1998; Koos 2011; Marquart-Pyatt 2012; Van Liere and Dunlap 1980). The suggested explanation is that higher education provides tools to understand the complexity of multifaceted problems of environmental degradation, such as climate change. Furthermore education is argued to generate new values and new priorities, and one such new priority is the importance of a healthy environment.

However, some studies conclude that there are no significant effects of education on pro-environmental policy support (e.g. Carman 1998) and there are also studies showing that people with more years of schooling are more likely to show environmental support on some measures but not on others (Newman and Fernandes 2015). In addition, recent studies have found that college students after one semester of studies in economics, law or political science do not feel more personal

responsibility for protecting the environment, rather, if anything, the results indicate a slight decrease in ascribed personal responsibility for environmental protection (Harring and Jagers 2015. Davies et al., in preparation).

Here, we use the same empirical material as Harring and Jagers (2015) and Davies et al. (in preparation)—a two-wave longitudinal study of Swedish college students—to further investigate what happens to students' perception of sustainability after one semester of college studies. Given that most of previous studies have focused on the effects of education on environmental support in general, we aim to provide a more sophisticated analysis of education on environmental support and sustainability beliefs. What kind of perceptions about causes of environmental degradation do students develop after one semester, and which actors do they see as responsible for causing environmental problems and protecting the environment?

It is important for scholars trying to understand how to shape sustainability education, and sustainable higher education institutions, to understand what kinds of underlying perspectives that university programs provide. Higher education might have strong effects on students' perceptions and beliefs which are more complex than just whether they show more environmental support or not. The students in our study (economists, law and political science students), and their conceptualization of sustainability, are of particular interest since many of them will hold positions in society where important decisions about sustainability issues will be made.

2 Higher Education and Environmental Support

As discussed in the introduction, education has been argued to foster norms of sustainability and many countries and higher education institutions have adopted United Nations (2005) call for sustainable education. A central aspect of whether higher education institutions are in accordance with a sustainable trajectory is of course whether core education provided by higher education institutions actually promotes sustainability.

In this text we focus on Sweden, and in the Swedish Higher Education Act (SFS 1992) it is clearly stated that higher education institutions in Sweden shall promote sustainability. To what extent higher education actually breeds sustainability norms among the students is however unclear. Even though many studies show that years of schooling is an important determinant of environmental support (e.g. Van Liere and Dunlap 1980), there are other studies arguing that certain university programs generate more cynicism and egoistic values. For example, several studies show that students in economics are more egoistic than other student groups and other people in general. It is argued that students in economics are taught models based on rational choice theory, where actors are described as self-interested rational profit-maximizing actors, which in turn affect their view about themselves and others. The major dispute in this discussion is whether students in economics become more egoistic during their studies (treatment effect) or whether students

with more egoistic values choose to study economics (selection effect) (Carter and Irons 1991; Frank et al. 1993; Frank and Schulze 2000; Frey and Meier 2003, 2005; Marwell and Ames 1981; Wang et al. 2011).

However, the potential negative effect of teaching rational choice theory is not limited to economics. Presenting a rather cynical view of political realities has also been argued to shape the views of political science students (Crawford 2007; Ostrom 1998; Steiner 1990), while students in law, being part of a very competitive and hierarchy-enhancing environment, are argued to develop egoistic and less egalitarian norms (Coulter et al. 2007; Grouzet 2014; Guimond et al. 2003; Sidanius et al. 2006). Thus, we have reasons to believe that students actually get more cynical after one semester of education, in the sense that they do not think that anyone can solve problems of environmental degradation, and they feel less responsibility.

H1: *After one semester students in economics, law and political science become more cynical in the case of environmental protection.*

Another debate within research on the effects of higher education revolves whether university studies are hierarchy-enhancing or hierarchy-attenuating (Chatard and Selimbegovic 2007). The results show that some programs, typically business schools, with disciplines such as law and economics, are hierarchy-enhancing while others, typically social science institutions, are hierarchy-attenuating (Guimond et al. 2003; Sidanius et al. 2006). Based on this research we have reason to believe that students who study at hierarchy-enhancing institutions develop stronger hierarchy norms and hence put larger confidence in elite actors, such as business actors and/or the government. If their studies also generate a belief that people in general are short-sighted this might generate an attitude that it is instead elite actors that have competence and power to actually achieve good outcomes. A closely related explanation would be that students perceive that a third party (or elite) intervention is necessary. If students recognize the collective action dilemma of environmental degradation this could trigger a demand for elite action in terms of government intervention (Harring 2016; Harring and Jagers 2013). We have reasons to believe that we will find stronger effects among economics and law students (hierarchy-enhancing) while less strong among social science students (hierarchy-attenuating, in our case political science students).

H2: *After one semester students in economics and law are more likely to think that elite actors have the competence and responsibility to protect the environment.*

Another potential development among Swedish college students is that education provides them with more structural perspectives on societal problems. With a structural perspective they do not point at certain actors (not themselves, nor the government or anyone else), but rather claim that it is the system within which these

actors act, that is the problem. Research has shown that different types of education influence where people place the responsibility for societal problems. For example, Guimond, Begin and Palmer (1989), Guimond and Palmer (1990) have shown that social science students are more likely to give structural explanations to problems of unemployment and poverty, while business school students are more likely to attribute this to individual factors. In one of their studies they found that social science students are even more likely than poor/unemployed to give attributions to structural factors. The authors believe that this can be explained by socialization. Social science students are taught that there are structural origins of these problems and are therefore more likely to provide structural explanations to the problem (Guimond et al. 1989; Guimond and Palmer 1990). Hence, a structural perspective is not about feeling personal responsibility or pointing at specific actors, but rather a view of an overarching perspective—the "system"—causing the problems.

H3: *After one semester social science students are more likely to give a structural perspective on sustainability issues.*

3 Methods and Material

We make use of unique two-wave longitudinal data from Swedish college students from seven different universities. The data were collected during their initial semester at the university. The first data collection was performed in the beginning of the semester, August/September 2014, and the second wave of data collection was performed in December/January 2014/2015, end of semester. The students were asked to complete the questionnaires in connection with their lectures. Participation was completely voluntary and students who participated received a cinema ticket.

As mentioned above we focus on three different types of higher education disciplines; economics (47 % of the sample); law (30 % of the sample) and political science (22 % of the sample). In the group that we were able to match between the first and second survey (N = 882), the majority were women (63 %). On a question about ideological position, 45 % considered themselves as being on the right, 37 % as being left, while 18 % considered themselves as neither left nor right. A selection of the questions was also answered by a control group provided by the Citizens Panel at the LORE institute at the University of Gothenburg.[1]

In order to measure *cynicism, attitudes to elite actors*, and *structural explanations* we make use of a number of statements from the same question battery where the students can rate to what degree they agree with the statements. The responses are reported on a five-point scale from "strongly disagree" to "strongly agree".

[1]For a more elaborated discussion about the data see www.lore.gu.se.

3.1 Cynicism

We measure and define cynicism in terms of students' perceptions of not having responsibility for protecting the environment—ascription of personal responsibility—and, secondly if they think that other actors have a responsibility (and/or can solve the problem of environmental degradation). We measure ascription of responsibility based on three questions; "My own lifestyle has contributed to the current environmental problems"; "I am co-responsible for protecting the world's environment"; and "I have no personal responsibility to protect the environment". The Cronbach's alpha value for these questions is quite low (0.53), we therefore chose to present the results statement by statement.

We also have a question that captures whether others are responsible, and the relationship between authorities and ordinary citizens: "Ordinary citizens and not just authorities and decision makers carry a great deal of responsibility for the environment".

3.2 Views on Elite Actors

In order to capture the respondents' view on elite actors we first have a question regarding responsibility of authorities: "Authorities and decision makers, not ordinary people, have the primary responsibility of preventing environmental destruction". We then have two questions about the role of business actors in the case of sustainability: "It is only the most environmentally friendly companies that survive on the market"; and "It is business actors that lead the development for a better environment". A first analysis of the questions shows that it does not make sense to build an index of *attitudes of elites* out of these questions as the Cronbach's alpha is very low (0.25). Hence, we review the results statement by statement (more on this in the results section).

3.3 Structural Explanations

Our last hypothesis concerns whether social science students are more likely to suggest structural explanations. We measure these structural explanations by two questions: "The organization of the current economic system is the most crucial question for the future of our environment, as this is what primarily affects the environment"; and "Reformation of economic structures is the key to managing our environmental problems", the Cronbach's alpha is good (0.75). However, we review these results also statement by statement.

In order to analyse the data and test the hypotheses we have performed a number of mean values comparisons for all students and also compared the means by discipline (economics, law and political science). Some of the questions are compared with results from the control group.

4 Results

We find that even though all students, after one semester, are more likely to think that their"own lifestyle has contributed to current environmental problems" (mean value difference (mvd) = 0.063*) they are less likely to agree with the statement "I am co-responsible for protecting the world's environment" (mvd = −0.074*) and more likely to agree with the statement "I have no personal responsibility to protect the environment" (mvd = 0.077**). These results (presented in Table 1) to some extent indicate an increase of cynicism. Students are more likely to think that they contribute to the problem but do not feel responsible, although it is important to stress that the size of the effects can be interpreted as pretty small.

Furthermore, we note that results on the question "Ordinary citizens and not just authorities and decision makers carry a great deal of responsibility for the environment" (mvd = −0.139***) show a decrease in all student groups, which suggests that students do become more cynical or at least they see a decrease in the responsibility that ordinary citizens have vis-à-vis authorities for protecting the environment. So, who is responsible?

One of our hypotheses proposes that students in economics and law put higher confidence in elite actors. First, results on their attitudes toward the government suggest that students in general are more likely to agree with the statement: "Authorities and decision makers, not ordinary people, have the primary responsibility of preventing environmental destruction" (0.215***). These results can be compared with the control group where there is actually an increase as well, but it is much smaller (0.09**). Focusing on the next elite group; business actors, we find that the students after one semester agree with both statements "It is only the most environmentally friendly companies that survive on the market" (0.111***) and "It is business actors that lead the development for a better environment" (0.121**).

However, when scrutinizing these results further and looking specifically at each student group, we find interesting differences, as there is no substantial change among the political scientists. Political science students are also least likely in the sample to agree with the statement "It is business actors that lead the development for a better environment" (mean value = 2.75). Yet, both law students (mean value = 3.115) and economists (mean value = 3.146) put more faith in business actors, and their faith in business actors increases after one semester of college studies. Hence we can see that *different types of elite group* matters and that political scientists have more faith in the government, while not in business actors.

The next hypothesis concerns whether political science students are more likely to suggest structural explanations after one semester. When studying the different student groups we actually see interesting differences again. Students in economics (−0.094*) are less likely to blame "the system" while political science students after one semester are more likely to think that reforming "the economic structures" is the key to managing environmental problems (0.177¤) This is in line with results from previous research; social science students are more likely to suggest structural

Table 1 Perceptions of responsibility in the case of sustainability among Swedish students during their first semester

	Wave 1	Wave 2	Difference	Significance	N
My own lifestyle has contributed to the current environmental problems					
Economists	3.753	3.776	0.024	ns	380
Law students	3.678	3.782	0.104	*	289
Political scientists	3.981	4.058	0.077	ns	207
Students total	3.782	3.845	0.063	*	876
Control group	3.703	3.770	0.067	*	887
I am co-responsible for protecting the world's environment					
Economists	4.447	4.371	−0.076	*	380
Law students	4.413	4.358	−0.056	ns	288
Political scientists	4.604	4.507	−0.097	*	207
Students total	4.473	4.398	−0.074	***	875
I have no personal responsibility to protect the environment					
Economists	1.707	1.742	0.034	ns	380
Law students	1.696	1.806	0.111	¤	289
Political scientists	1.509	1.616	0.106	*	206
Students total	1.657	1.734	0.077	**	875
Ordinary citizens and not just authorities and decision makers carry a great deal of responsibility for the environment					
Economists	4.318	4.186	−0.131	***	380
Law students	4.298	4.130	−0.170	***	288
Political scientists	4.332	4.221	−0.111	**	208
Students-total	4.314	4.175	−0.139	***	878
Authorities and decision makers, not ordinary people, have the primary responsibility of preventing environmental destruction					
Economists	2.458	2.674	0.216	***	380
Law students	2.578	2.789	0.211	**	289
Political scientists	2.512	2.729	0.217	**	206
Students-total	2.510	2.725	0.215	***	875
Control	2.773	2.864	0.090	**	868
It is only the most environmentally friendly companies that survive on the market					
Economists	2.018	2.103	0.084	*	379
Law students	1.886	2.121	0.235	***	289
Political scientists	1.887	1.872	−0.015	ns	204
Students-total	1.944	2.055	0.111	***	872
It is business actors that lead the development for a better environment					
Economists	3.010	3.146	0.135	**	377
Law students	2.923	3.115	0.192	**	287
Political scientists	2.756	2.751	−0.005	ns	205
Students-total	2.921	3.043	0.121	***	869

(continued)

Table 1 (continued)

	Wave 1	Wave 2	Difference	Significance	N
The organization of the current economic system is the most crucial question for the future of our environment, as this is what primarily affects the environment					
Economists	3.437	3.343	−0.094	*	382
Law students	3.307	3.404	0.098	¤	287
Political scientists	3.667	3.706	0.039	ns	204
Students-total	3.448	3.448	0.000	ns	873
Control	3.704	3.709	0.005	ns	862
To reform the economic structures are the key to managing our environmental problems					
Economists	3.358	3.305	−0.053	ns	380
Law students	3.203	3.231	0.028	ns	286
Political scientists	3.568	3.684	0.117	¤	206
Students-total	3.357	3.370	0.014	ns	872
Control	3.681	3.696	0.015	ns	864

Comment Paired sample t-tests. For some of the statements non-parametric tests (Wilcoxon signed rank tests) have been performed. *Ns* not statistically significant, $p < 0.10$, *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. All estimates are based on five-point scales. For the exact wordings of the questions, see the methods section

explanations while business/economics students are less likely to do so (Guimond et al. 1989; Guimond and Palmer 1990).

5 Concluding Remarks

In summary, the results show that students change their positions on several of the statements. We find a weak decrease in their feeling of personal responsibility and that ordinary citizens in general are responsible. Instead, they are more willing to put confidence in other actors and institutions, and in change of structures.

Firstly, we find interesting differences between students in economics and law, and students in political science. Political science students put more confidence in the government while students in economics and law put more confidence in business actors. One potential explanation would be that political scientists to a large extent study government and policy, and therefore the acceptance of state intervention increases, while students in economics study markets and therefore gain more confidence in market actors.

Secondly, political science students are more likely to give structural perspectives on sustainability issues, while economists are less likely to do so. Whether or not this encourages the individual student to act for more sustainability would be an interesting area for future research. Agreeing with the statement "To reform the economic structures is the key to managing our environmental problems" and mistrusting business actors might be related to each other. It is maybe less likely to

believe that business actors can lead change towards sustainability if you think that the economic structures need to be reformed. But that is to a large extent dependent on how students actually interpret the statement. Students within different disciplines can actually interpret the statement differently, as reforming economic structures could imply opposing positions such as both regulation of markets and privatization.

Finally, we believe that these results contribute to the debate on the effects of higher education on environmental support in two ways. First, our results show that higher education provides students with new views on sustainability, and that these are more nuanced than just reporting whether students show more or less environmental support. Second, we make use of a longitudinal dataset whereas much of the previous research on higher education and environmental support has used cross-sectional data. One limitation however with our study is of course that we only study the educational effects of one semester. On the other hand, our results show that education in economics, law and political science have various effects after *only* one semester, and if we think of these effects in terms of socialization, they would potentially increase over time (see discussion in Chatard and Selimbegovic 2007).

Environmental degradation is a societal problem. It is the organization of society and the actions of individuals living within these societies that generate environmental degradation; hence it is societies that can solve these problems. Students, both as citizens and professionals, will play an important role in how society tackles challenges of sustainability. Here, we have particularly reported educational effects of studies in economics, law and political science on students' views on responsibility and change towards sustainability. Our results are important when looking at how to improve sustainability education, and for bettering our understanding of its role in societal change. Improving our knowledge of the kinds of knowledge, perspectives, and tools, that major university programs provide are of importance for building environmentally sustainable societies.

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Author Biographies

Niklas Harring is a researcher and lecturer at the Department of Political Science, University of Gothenburg. He is affiliated to the Department of Humanities and Social Science Education, Stockholm University, and The Centre for Collective Action Research, University of Gothenburg

Cecilia Lundholm is professor in educational science with a specialisation in teaching and learning in the social sciences at the Department of Humanities and Social Science Education, Stockholm University

Tomas Torbjörnsson is a PhD in educational science at the Department of Humanities and Social Science Education, Stockholm University

Student Participation and Engagement in Sustainable Human Development: A Value Education Approach

Shobha Sundaresan and Sushama Bavle

Abstract

It is recognized worldwide that higher education institutions are key drivers to sustainable development. Contemporary global challenges related to issues of climate change, globalization, growing interreligious conflict, increasing social inequities and environmental degradation confront education in the present era. This paper provides an insight on how higher education institutions can address these global challenges by adopting value education towards human development for a sustainable future. The effectiveness of value education for learners in their personal transformation and how such an education based on shared global values can foster a peaceful, just and sustainable world is examined. This research study aimed at analyzing the relevance of student participation and engagement in value education, **S**tudent **A**nd **T**eacher **V**alue **A**ssimilation (**SATVA**) approach, towards enabling resiliency, managing vulnerability and supporting adaptation among learners in higher education institutions. The sample for the study constituted students who have undergone the value education programme. The results indicated that holistic development of learners makes them responsible and ethical global citizens, equipped to contribute to societal transformation for sustainable human development. This paper will be relevant to anyone interested in adopting a systemic approach to value education for sustainable human development.

S. Sundaresan (✉)
Department of Management Studies, Maharani Lakshmi Ammanni College for Women, 18th Cross, Malleswaram, Bangalore 560012, India
e-mail: shobha.sundaresan@mlacw.org

S. Bavle
Department of Commerce, Maharani Lakshmi Ammanni College for Women, 18th Cross, Malleswaram, Bangalore 560012, India
e-mail: sushama.bavle@mlacw.org

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Resiliency · Vulnerability · Adaptability · Value education · Sustainable development

1 Introduction: Values and Sustainable Human Development (SHD)

The term SHD refers to development that promotes the integral human development (IHD) of people today without compromising the IHD of people tomorrow (Gutierrez 2011). The prototype was developed on the bases of Brundtland Report (1987) and Sen (1999) definitions with additional emphasis on the integration of the physical, psychological and spiritual needs of people. IHD entails holistic development of each human being, not in isolation, but in solidarity with others to foster justice, peace and encapsulates all dimensions of human well being. Value education and learning lie at the heart of approaches to sustainable development to realise the vision of education that seeks to empower people to assume responsibility for creating a sustainable future (UNESCO 2005a, b). The place of sustainability in the curriculum of higher education is not one of integration, but rather one of innovation and systemic change that will allow for more transformative learning emphasizing learning for being, knowing and doing (Wals and Corcoran 2006). The triple triad implicit in the Technology for Human Development approach—science, technology and society; knowledge (cognitive skills), practices (procedural skills) and values (attitudinal skills); and technical, managerial—relational, and political—strategic—together with its multi-level (macro, meso and micro), multi-disciplinary and multi-sector (private, public and non-profit) implementation may well be a useful building block towards the search for a sustainable development model (Foguet and Carramza 2004). Citizenship Education has provided an introduction to ways in which students can develop the knowledge, skills and commitment for active and informed citizenship and to consider ways of teaching about citizenship for sustainable futures across the curriculum (UNESCO 2010). Hopkinson et al. (2008) described the implementation of, successes of, and lessons learnt from the Ecoversity initiative, a pilot programme at University of Bradford that aims to integrate education for sustainable development into both the formal curriculum in all areas of study and the informal curriculum of life on campus. Pisano (2012) clarified the concepts of resilience, systems thinking and SD focussing on the explanation of crucial concepts: thresholds, the adaptive cycle, panarchy, resilience, adaptability and transformability. It is argued that resilience of a system needs to be considered in terms of the attributes that govern the system's dynamics. Three related attributes of social—ecological systems determine their future trajectories: resilience, adaptability, and transformability (Walker et al. 2004). The concept of resilience is a profound shift

in traditional perspectives, which attempt to control changes in systems that are assumed to be stable, to a more realistic viewpoint aimed at sustaining and enhancing the capacity of socio-ecological systems to adapt to uncertainty and response (Adger et al. 2005). According to UNESCO (2005a, b), ESD is based on the principles and values that underlie sustainable development. It deals with the well being of all three domains of sustainability—environment, society and economy; promotes lifelong learning; is locally relevant and culturally appropriate. It is not only based on local needs, perceptions and conditions, but also acknowledges that fulfilling local needs often has international effects and consequences. It engages formal, non-formal and informal education; is interdisciplinary and uses a variety of pedagogical techniques that promote participatory learning and higher order thinking skills. ESD encourages a shift from viewing education as a delivery mechanism to a lifelong, holistic and inclusive process (ICEE 2007). ESD is a vision of education that seeks to empower people to assume responsibility for creating a sustainable future and aims at improving access to quality basic education, reorienting education curricula, training and raising public awareness as well as helping people to develop the behaviours, skills and knowledge they need, now and in the future (UNESCO 2002).

2 Student and Teacher Value Assimilation (SATVA): The Value Education Approach of mLAC

Maharani Lakshmi Ammanni College for Women (mLAC, previously MLACW) established in 1972 is an institution located in Bangalore, India, offering under-graduate, post-graduate and doctoral programmes to women students. mLAC, with over 2000 girl students, 150 teachers and 21 departments has been providing exemplary service to society by empowering women through education (www.mlacw.edu.in). The institution focuses upon holistic development of learners in keeping with the motto, ***Sheelam Paramabhushanam*** meaning *Character is the supreme ornament*. The vision of the institution has therefore been appropriately stated as: *To empower women through education for character formation*. The institution has partnered with DISHA, a non-governmental organization promoting value initiatives among youth, for providing value education to undergraduate students since 2005. The theme of the program offered by DISHA is *Know yourself, Know your country, Know your culture.* DISHA has also been involved in training teachers to ensure that there is alignment of the desired values among teachers and students for SHD. The program appropriately titled, Student And Teacher Value Assimilation, SATVA is to enable each learner discover her unique potential, become aware of all the great spiritual and cultural traditions of the nation and their relevance in the global context. The focus is essentially on human development by revealing to learners the spiritual aspect to human life. A variety of pedagogical

techniques that promote participatory learning are adopted. Emphasis is laid upon open and free communication, problem solving, creativity and critical reflection of the learners' own perspectives. Experiential and interactive approaches are adopted in order to encourage students to develop and reflect on their own and others' values. Quiz, audio-visual sessions, case studies, group counselling, team building games, yoga and community volunteering are some of the pedagogies adopted for enabling a dynamic learning experience. The physical, intellectual, emotional, social and spiritual domains of learners' personality are addressed.

3 Purpose

This study was undertaken to investigate the role of value education in building resiliency, reducing vulnerability and enhancing adaptability for SHD and to propose guidelines for imparting the same. The main idea behind this study was to explore the significance of integrating values education for SHD in institutions of higher learning. This study was an attempt to understand the relevance of an innovative value education approach, SATVA, offered to learners at mLAC. It has focused upon the role of student participation and engagement in value education for equipping them with skills to build resilience, reduce vulnerability and enhance adaptability towards SHD. This study has provided an insight into how the value education initiatives of mLAC align with the UNESCO's aims of education.

4 Definitions of Terms

Vulnerability, Resilience and Adaptive capacity are different manifestations of more general processes of response to changes in the relationship between open dynamical systems and their external environment (Gallopin 2006).

Resilience is a construct that involves interaction between adversity and individual's internal and external protective factors—as well developed competencies—that allow one to overcome adversities (Luthar and Zigler 1991; Rutter 1987).

According to IFRC, Vulnerability can be defined as the diminished capacity of an individual or group to anticipate, cope with, resist and recover from the impact of a natural or man-made hazard. It is associated with poverty and can arise when people are isolated, insecure and defenceless in the face of risk, shock or stress.

Adaptability can be defined as the ability of individuals in handling emergency or crisis situations; handling work stress; solving problems creatively; dealing with uncertain and unpredictable situations; learning new work tasks, technologies and procedures; demonstrating interpersonal, cultural and physically oriented flexibility (Pulakos et al. 2006).

5 Methodology

The study was conducted to examine the role of SATVA with specific reference to building resilience, reducing vulnerability and enhancing adaptability towards SHD among learners in mLAC. The sample consisted of 613 students with a response rate of about 30 % of the entire population. Characteristics of the sample with respect to demographic profile such as parents' education, parents' occupation and annual family income were also elicited.

5.1 Instrument

The tool used for the purpose of this study was a structured questionnaire comprising of 21 items, developed and aimed to assess undergraduate students' value orientation towards SHD. These items were designed on a 5-point Likert scale [strongly disagree (1), disagree (2), can't say (3), agree (4), strongly agree (5)]. Undergraduate students' values pertaining to building resilience, reducing vulnerability and enhancing adaptability consisted of 7 items each. To meet content validity concerns, the questionnaire was given to experts whose area of research covers value education. Each of the 21 items was evaluated and revised after considering the responses and comments of the experts to arrive at a consensus before the questionnaire was piloted and implemented.

5.2 Variables of the Study

In this study variables used to test the hypotheses were categorised as observed variables and latent variables. The observed variables were those that were directly measurable and the latent variables were those that have been indirectly measured through observed variables. The latent variables were building resiliency (BR), reducing vulnerability (RV) and enhancing adaptability (EA). The observed variables related to respondents' values pertaining to building resilience were *self-esteem, self control, self confidence, emotional balance, internal locus of control, self monitoring and self expression* (APA 2002). The second set of observed variables were related to respondents' values towards reducing vulnerability such as *collaboration, professionalism, far-sightedness, humanitarianism, spirit of inquiry, patriotism and adaptive capacity* (UNDP's Human Development Report 2014). The third set of observed variables were associated with enhancing adaptability and consisted of values such as *receptiveness, sensitivity, national pride, inclusivity, ecological consciousness, responsiveness and global consciousness* (UNESCO World Report 2009).

5.3 Procedure

Data was collected through a web based survey by administering the questionnaire at two levels—PreSATVA and PostSATVA during October 2015 and December 2015 respectively. The questions 1–7 addressed factors related to BR, questions 8–14 addressed factors related to RV and questions 9–21 addressed factors relating to EA.

5.4 Data Analysis

The significance of change ($\alpha < 0.05$) in each of the observed variables and latent variables (n = 613) were analysed through t-test and Z test using MS Excel. The predictability of the latent variables using regression coefficients and their significance ($\alpha < 0.05$) was studied.

5.5 Hypotheses of the Study

The following hypotheses have been formulated and tested:

H0	Value education has no role in enabling SHD
HA	Value education enables SHD
H0 (a)	Value education does not build resiliency
HA (a)	Value education builds resiliency
H0 (b)	Value education does not reduce vulnerability
HA (b)	Value education reduces vulnerability
H0 (c)	Value education does not facilitate adaptability
HA (c)	Value education facilitates adaptability.

6 Results

The hypotheses were tested to examine the role of value education in BR, RV and EA for SHD. An analysis of the demographic profile revealed that the majority of the students (over 70 %) belonged to the low income group and over 85 % of them were from families where the parents were not graduates. The majority (78 %) of the mothers were homemakers and the fathers were either self employed (40 %) or in service (40 %).

The 21 items in the structured questionnaire aimed to assess undergraduate students' value orientation categorised as latent variables and observed variables were measured on a scale of 1–5. Table 1 depicts respondents' mean rating.

Table 1 Mean rating for variables PreSATVA and PostSATVA

Latent variables	Observed variables	Mean rating[a]	
		PreSATVA	PostSATVA
BR	Self-esteem	1.84	4.64
	Self control	1.7	4.68
	Self confidence	1.7	4.64
	Emotional balance	1.64	4.54
	Internal locus of control	1.62	4.56
	Self monitoring	1.62	4.58
	Self expression	1.64	4.62
	Overall score (BR)	1.68	4.61
RV	Collaboration	1.84	4.6
	Professionalism	1.9	4.58
	Far-sightedness	1.7	4.68
	Humanitarianism	1.8	4.68
	Spirit of inquiry	1.86	4.52
	Patriotism	1.94	4.76
	Adaptive capacity	1.82	4.66
	Overall score (RV)	1.84	4.64
EA	Receptiveness	1.84	4.66
	Sensitivity	2.04	4.62
	National pride	2.12	4.76
	Inclusivity	1.92	4.66
	Ecological consciousness	1.8	4.74
	Responsiveness	1.76	4.78
	Global consciousness	1.58	4.56
	Overall score (EA)	1.87	4.68
SHD	BR + RV + EA = SHD	1.79	4.64

[a]Values are in mean rating (1–5). *BR* building resilience, *RV* reducing vulnerability, *EA* enhancing adaptability, *SHD* sustainable human development

The mean rating for PreSATVA was in the range of 1–2 (disagree to strongly disagree) and PostSATVA 4–5 (agree to strongly agree) indicating that PreSATVA students at the undergraduate level were under prepared to meet the challenges of the global environment and PostSATVA students are better prepared to adapt and grow in a dynamic global environment (Table 1).

The F-test for each of the factors revealed that variances PreSATVA and PostSATVA were not the same. Therefore the t-test assuming unequal variances was conducted to test the hypotheses and the t values were derived as shown in Table 2.

In the t-test, it was observed that t Stat < −t Critical two-tail for each of the variables. Therefore, the null hypotheses were rejected and the alternate hypotheses were accepted.

The percentage change and its significance for each of the observed variables is presented in Table 3 (Fig. 1).

Table 2 Mean rating and t values for sustainability related variables

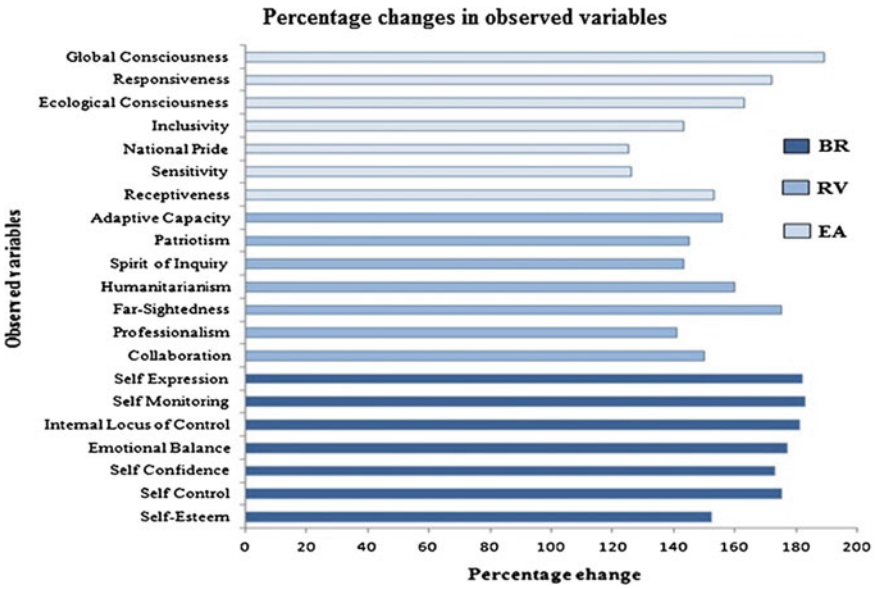
Latent variables	Mean rating		t-value	t critical two-tail
	PreSATVA	PostSATVA		
BR	1.68	4.61	−83.32	2.23*
RV	1.84	4.64	−67.16	2.18*
EA	1.87	4.68	−37.70	2.31*
SHD	1.79	4.64	−81.06	2.04*

BR building resilience, *RV* reducing vulnerability, *EA* enhancing adaptability, *SHD* sustainable human development
*Significant at $\alpha < 0.05$

Table 3 Z score significance of changes in observed variables

Observed variables	Mean score		% change	Z-score significance	Significance
	PreSATVA	PostSATVA			
Self-esteem	1.84	4.64	152	0.985	Significant change
Self control	1.7	4.68	175	0.981	Significant change
Self confidence	1.7	4.64	173	0.974	–
Emotional balance	1.64	4.54	177	0.969	–
Internal locus of control	1.62	4.56	181	0.975	Significant change
Self monitoring	1.62	4.58	183	0.972	–
Self expression	1.64	4.62	182	0.977	Significant change
Collaboration	1.84	4.6	150	0.979	Significant change
Professionalism	1.90	4.58	141	0.984	Significant change
Far-sightedness	1.70	4.68	175	0.975	–
Humanitarianism	1.80	4.68	160	0.978	Significant change
Spirit of inquiry	1.86	4.52	143	0.978	Significant change
Patriotism	1.94	4.76	145	0.988	Significant change
Adaptive capacity	1.82	4.66	156	0.992	Significant change
Receptiveness	1.84	4.66	153	0.982	Significant change
sensitivity	2.04	4.62	126	0.967	–
National pride	2.12	4.76	125	0.982	Significant change
Inclusivity	1.92	4.66	143	0.973	–
Ecological consciousness	1.8	4.74	163	0.984	Significant change
Responsiveness	1.76	4.78	172	0.978	Significant change
Global consciousness	1.58	4.56	189	0.957	–

*Significant at $\alpha < 0.05$



BR;Building Resilience, RV; Reducing Vulnerability, EA;Enhancing Adaptability

Fig. 1 Percentage changes in observed variables

It is observed from the above analysis that PostSATVA there was statistically significant change in 14 of the 21 sustainability related observed variables. The highest significant percentage change was observed in self expression, internal locus of control, responsiveness and humanitarianism. Overall, the SATVA programme has had a direct positive effect on participants' ability to build resilience, reduce vulnerability and enhance adaptability. Regression analysis results are illustrated in Table 4.

The predicted intercept and coefficient factors were assessed for BR versus RV, BR versus EA, RV versus BR, RV versus EA, EA versus RV and EA versus BR. All the coefficients were statistically significant at $\alpha = 0.05$ while only the intercepts of BR versus RV and BR versus EA were significant at the same level as shown in Fig. 2.

Table 4 Regression between each of the three latent variables

Regression	Intercept	Co-efficient	P-value co-efficient	P-value intercept	R^2 value
BR predicting RV	0.431	0.893	0.00	0.00*	0.897185
BR predicting EA	0.524	0.875	0.00	0.00*	0.838637

BR Building resilience, *RV* Reducing vulnerability, *EA* Enhancing adaptability
*significant at $\alpha < 0.05$

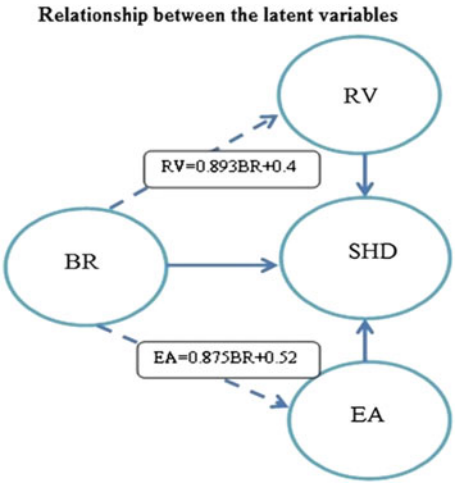


Fig. 2 Relationship between the latent variables

BR;Building Resilience, RV; Reducing Vulnerability, EA; Enhancing Adaptability. SHD; Sustainable Human Development

7 Discussions and Implications

In the present times, societies are characterised by changes that are frequent and which occur in sequential chains. Such changes affect a wide range of individual experiences and functional aspects of societies. The educational system of every society being related to the total social system, must prepare the learners to adapt to the changes in values and attitudes, skills and knowledge so as to encourage changes in behaviour that will create a more sustainable future. It must cultivate among the youth necessary physical, intellectual, emotional, social and spiritual dispositions and attitudes for dealing with change and train them to respond intelligently to change when it occurs. It has become imperative for the educational system to enable the internalisation of all these new values in the learners so as to build a sustainable society. The integration of values in education can initiate the personal and societal changes of attitudes and motivate learners to adopt sustainable lifestyles. Most of the challenges such as climate change, refugees seeking asylum or violations of human rights are essentially man made encompassing all dimensions of human life. The stupendous growth in intellectual content and technological power has enhanced the quality of life for human beings, but not without causing damage to nature. Such technological progress has also resulted in a deficit of values such as compassion, empathy or respect for diverse world views and is characterised by individualism, materialism, exploitation and destruction. Most instances related to exploitation and destruction of environment in current times

may be attributed to lack of relevant knowledge. It is important to ensure that knowledge related to the various issues concerning sustainable development must be communicated at all levels effectively. However, knowledge will remain irrelevant if not supported by a moral and ethical framework. Scientific knowledge combined with value education will ensure that learners understand the relevance of behaviours that support sustainable development. Higher education institutions have an important role to play as learners in educational institutions will become the decision makers of tomorrow. It has therefore become necessary for higher education institutions to focus on long term initiatives and contribute to the creation of a peaceful, just and sustainable world. Higher education institutions operate in a dynamic environment and the faster institutions anticipate and respond to change, the greater is their capacity to be resilient thereby capable of implementing adaptation strategies. In addressing SHD from a values based perspective, there is potential to build a more sustainable and advancing civilization. Future scenarios must be characterized by shared values based on spiritual principles focussing on social justice, global solidarity and service to humanity so as to ensure sustainable development. A collaborative, integrative value-driven and knowledge based educational approach is imperative to ensure economic, social and spiritual progress of learners for SHD.

A value education model focusing on attributes that determine behaviours and skills required for SHD should equip professionals of the future with the right knowledge, the right skills and the right values and attitudes (Parkin et al. 2004). These attributes will enable students to take appropriate decisions in order to create a sustainable future world. The present study focuses upon the role of value education in building resiliency, reducing vulnerability and enhancing adaptability towards SHD. The results of the study were found to be consistent with the inputs provided by the Bruntland Report (Our Common Future-1987) regarding education and sustainability and the Johannesburg World Summit on Sustainable Development in 2002 which helped in signalling that education and learning lie at the heart of approaches to sustainable development (UNESCO 2005a, b, International Implementation Scheme). In other words, education plays a vital role in moulding students' behaviours towards the environment for taking more sustainable actions. This study is aligned to the previous study by Munir and Aftab (2012) who proposed that education has to be value-added and value-oriented to promote fundamental qualities like compassion, truthfulness, peace and justice; to become responsible citizens in personal and social life, to rise above prejudices on religion, language, sex, caste or creed and to develop proper attitudes towards one's own self and fellow beings. Bhatia and Dash (2011) conceptualised the role of education in promoting values and attitudes of responsible citizenship and in nurturing creative and emotional development. Sahin et al. (2012) pointed out that attitudes and values were significant determinants of university students' behaviours pertaining to sustainability. The finding related to building resilience as a result of value education has wide implications for SHD in the context of higher education. Self esteem, self control, self expression and internal locus of control have emerged as strong variables of this study in building resilience among undergraduate students.

Collaboration, professionalism, humanitarianism, spirit of inquiry, patriotism and adaptive capacity have a significant role in reducing vulnerability. The results of this study also point to the direct positive effect of value education towards receptiveness, sense of national pride, ecological consciousness and responsiveness in enhancing adaptability among students. Concerning the interrelationships between building resilience, reducing vulnerability and enhancing adaptability, the results of the current study indicated that greater the resilience, lesser the vulnerability and higher the adaptability among students for enabling SHD. One of the statistically significant findings of the study is that students can be enabled to build resilience for reducing vulnerability which will directly enhance adaptability.

8 Conclusion

ESD draws on the Delors Report and the four pillars or fundamental types of learning: learning to know, learning to be, learning to live together and learning to do. According to Combes, the addition of the fifth pillar: learning to transform oneself and society was suggested by a number of Latin American educators and by UNICEF (Hayward et al. 2007). The present study revealed that the SATVA program is aligned to these five pillars of Education for Sustainable Development (UNESCO 1995–2010) which is observed in the changes in attitudes and values of students (Fig. 3). The significant change in the spirit of inquiry and receptiveness, the value of *learning to know* among participants PostSATVA is a clear indicator of the success of the program. The students have been enabled to recognize the evolving nature of the concept of sustainability, address the ever growing needs of the local community with a global perspective. The SATVA programme has succeeded in enhancing the values of *learning to be*, self esteem, self control and sense of national pride among students, thereby contributing to the well being of the individual, the community and the nation for SHD. Collaboration, professionalism, humanitarianism, patriotism, adaptive capacity and ecological consciousness are values of *learning to live together* that students have developed PostSATVA. These values have resulted in building social tolerance, environmental consciousness, adaptable workforce and better quality of life. In the light of the results of this study, it is seen that students have developed the value of *learning to do,* by demonstrating greater responsiveness to build a sustainable and safe ecosystem for everyone. A significant positive change in internal locus of control, self expression and patriotism among students PostSATVA indicates that learners are empowered to assume responsibility for creating a sustainable future and are capable of integrating the values inherent in sustainable development into all aspects of their lives thereby *learning to transform oneself and society*. The outcome of this approach towards SHD is in congruence with the requirements of graduate outcomes towards 'sustainability literacy' as articulated by the Guidance document for UK Higher Education Providers (2014). The paper has provided a model of SHD that can be adopted by similar institutions for achieving a sustainable future.

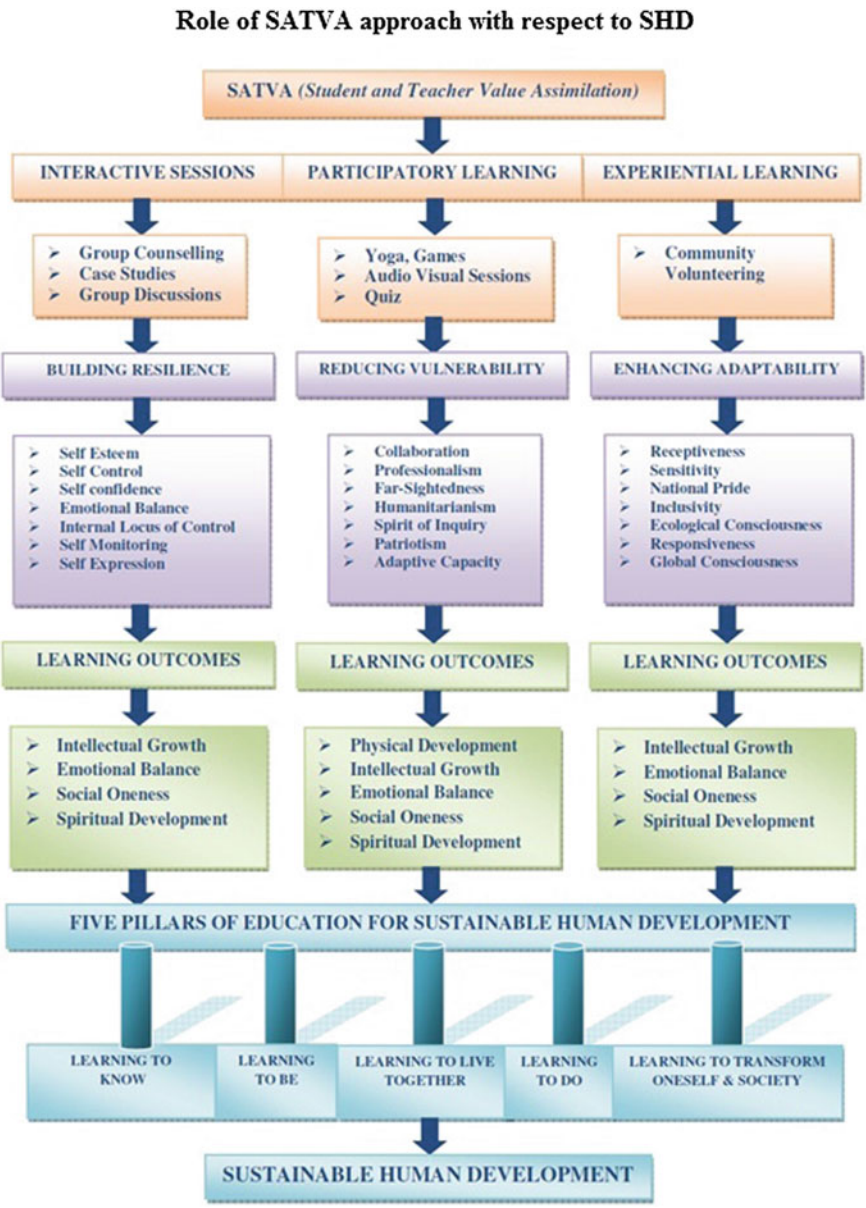


Fig. 3 Role of SATVA approach with respect to SHD

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Author Biographies

Shobha Sundaresan is Head of the Department of Management Studies and Member, Internal Quality Assurance Cell and Coordinator of Faculty Development Programmes of Maharani Lakshmi Ammanni College for Women (mLAC), Bangalore. She holds Post-Graduate degrees in Commerce and Education from the University of Bombay and has completed the MS (Counseling and Psychotherapy) program of Kuvempu University with a first rank. The first few years of her career, spanning over 29 years, were spent in the industry. She started her career in teaching in Mumbai and currently teaches Management Process and other related subjects for students at the undergraduate level at mLAC, Bangalore. She is also a resource person for the UGC Capacity building programmes of women managers in higher education and is actively engaged in personality development and counseling of students. She is a resource person for DISHA [An organisation focussing upon enriching lives through values] and founder member of SAMRUDDHI [An association focussing upon selfless service for character development and harmonious existence with the environment]. She provides research guidance to students pursuing MBA course of various universities. Her interests include pursuing research in the field of education, specifically in the area of value education, providing guidance to children with learning difficulties, facilitating personality development of students, engaging in social and community projects and providing counselling services.

Sushama Bavle is the Head of the Department of Commerce and Coordinator, Internal Quality Assurance Cell (IQAC) at Maharani Lakshmi Ammanni College for Women (mLAC), Bangalore. She started her teaching career in the year 1983 after completing the B.Com (Hons.) programme from Lady Shri Ram College, New Delhi and M.Com from Delhi University. She is currently teaching both at the undergraduate and post graduate levels. Her main areas of interest include Advanced Management Accounting and Taxation. She has also engaged in extensive research in the area of Entrepreneurship and has undertaken a research project to understand the role of entrepreneurship in alleviation of poverty in rural India. She is currently pursuing a Doctoral program on Women Entrepreneurship. Her role as coordinator of IQAC spurred her on to explore methods by which to enhance the quality of education in the institution. She has thus initiated value education programmes for students across all departments of the institution. She provides research guidance to students pursuing Post Graduation in Commerce of Bangalore University. As the Head of Department of Commerce she has led her team of dedicated teachers in pioneering the establishment of Business Lab in Bangalore University.

Food (In)Security Within a University Community: The Experiences of Students, Staff and Faculty at a Sustainable Institution

Annie L. Booth and Melanie Anderson

Abstract

The University of Northern British Columbia (UNBC), located in north-central British Columbia, Canada, began the process for developing an institutional Food Strategy in 2014. However a critical missing component of this strategy is understanding the nature of food security within the university's population as a basis from which to build a comprehensive food strategy. In 2015, research was undertaken to assess levels of food security within UNBC. Unlike other such projects within educational institutions, this project treated the university as the community and assessed food security levels within that community, including not just undergraduate and graduate students, but the faculty and academic staff working at the university as well. The project assessed the reasons for the level of food security within the community (i.e. lack of funds, time, knowledge or easy access); what factors contributed to or exacerbated levels of food security (supporting dependents, being a single parent, employment status, disabilities, socio-economic characteristics, etc.), and worked with community members on identifying solutions which the university, as a community, could undertake in support of that community.

Keywords

Food insecurity · University students

A.L. Booth (✉)
Ecosystem Science and Management Program, University of Northern British Columbia, 3333 University Way, Prince George, BC V2N 4Z9, Canada
e-mail: annie.booth@unbc.ca

M. Anderson
Environmental Studies Program, University of Northern British Columbia, 3333 University Way, Prince George, BC V2N 4Z9, Canada
e-mail: Melanie.Anderson@unbc.ca

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1 Introduction

Food insecurity is a growing concern in developed countries. It is remarkable that, in some of the wealthiest countries in the 21st century, a significant percentage of citizens are food insecure. Food insecurity is defined as

> "the inability to access and procure, through conventional avenues, nutritionally adequate foods capable of supporting an active and health life." (Micevski et al. 2014).

One population coming under global study over food insecurity is university/college students. Post-secondary students have unique characteristics, they are usually adults, but by choice not usually within the full-time labor pool, a distinct population when discussing food insecurity. They also face a conundrum: to endure deliberate financial insecurity (leading to food insecurity) in hopes that this sacrifice will improve future circumstances. Modern society places considerable stress on the desirability of a post-secondary degree (critical for long term employment success). Given the pressure that students face to participate in this system, it is troubling that they often have higher levels of food insecurity than that of their country of residence.

In the last few decades, post-secondary institutions have grown interested in environmental sustainability, evidenced by the popularity of ventures such as the Talloires Declaration (in which educational institutions promise to promote sustainability (http://www.ulsf.org/programs_talloires.html; last accessed 1/25/2016), and a rise in agencies promoting campus sustainability (i.e. the Association for Advancement of Sustainability in Higher Education in North America). A commitment to local, organic or sustainable food systems is a regular piece of the sustainability picture for institutions, but broader discussion on what this means might be required. Environmental justice (Mitchell 2004) argues that sustainability cannot simply be about saving the non-human world from human depredations, but must also ensure vulnerable humans are protected from human depredations and the consequences of environmental degradation. Universities striving towards sustainability must themselves recognize this dual need in their planning, recognizing their own institutional responsibility for the well-being of the environment affected by their footprint as well as the well-being of their human "community." While "starving students" are a common image, evoked nostalgically or as a joke, the reality of food insecurity amongst a vulnerable population is far from humorous and should be addressed within university sustainability planning, in addition to the impacts of the production, consumption and disposal of food.

In this article, researchers report on an investigation into levels of food insecurity at a small Canadian university, the University of Northern British Columbia (UNBC), as well as factors associated with food insecurity and potential institutional responses.[1] As the research was requested by UNBC's Office of Sustainability as a component of a Food Strategy, we chose to investigate food insecurity at an institutional level, and surveyed university staff and faculty as well as students.

[1]Funding for this study was provided by a UNBC Green Grant.

While one hypothesis was that students would demonstrate a significant level of food insecurity, a second hypothesis posited that staff, particularly at lower salaries, as well as untenured faculty, might also demonstrate some food insecurity.

2 Literature Review

Recent research demonstrates a considerable range in the levels of food insecurity among post-secondary students across different institutions and countries, ranging from an estimated 10.2 % to a high of 59 % of students surveyed (Table 1).

Drawing generalizations from these studies is difficult, they are site specific and the methodology vary and cannot be compared (Cady 2014). Given the vast range in reported food insecurity levels among and across student populations, risk factors for food insecurity might be site-specific as well. Much more research, especially comparing across types of institutions and locations, is needed. However, the studies are troubling. As Cady (2014) notes, "'Are these studies [on post-secondary food insecurity] accurate' and if so, 'Why are college students experiencing higher instances of food insecurity than the general … population?'"

Nellum (2015), for example reports a United States study which found that 49.3 % of its clients in college using foodbanks must choose between either educational expenses or food every year. Goldrick-Rab and Broton (2015) surveyed 10 community colleges in 10 states and found that 1 in 5 students go hungry. Patton-Lopez et al. (2014) found in their Oregon study that 59 % of students surveyed were food insecure. Lower, but still troubling levels of food insecurity were found in other studies: 20 % at KwaZulu-Natal, South Africa (Munro et al. 2013), 19.4 % at a California university (Hanna 2014), 18 % at an Australian university (Micevski et al. 2014), and 21 % at the University of Hawai'i at Manoa (Chaparro et al. 2009). Rates of student food insecurity were double or triple that of the region in which the institution was located (Cady 2014).

A number of risk factors for food insecurity have been identified. Students living off-campus but not with relatives are at greater risk (Chaparro et al. 2009; Micevski et al. 2014). Ethnicity was also a factor, particularly for Indigenous students (Chaparro et al. 2009). Micevski et al. (2014) found that students receiving government financial aid were at high risk. Patton-Lopez et al. (2014) agree, finding that food insecurity was worse among those from disadvantaged or lower middle-class backgrounds. Nellum (2015) suggests that food insecurity might be linked to the growth in non-traditional students: older, the first in their families to attend college, and hailing from lower-income or communities of color. Hanna (2014) found that students under 24 years were most likely to be food insecure.

Other causes are lifestyle issues. Hanna (2014) notes the obvious, that lack of money was the significant factor in being food insecure, however insufficient time to shop or cook or difficulty in getting to a food-store, a lack of knowledge around food preparation and cooking (Gaines et al. 2014), or an inability to "shop smart" and poor money management skills (Koller 2014) are also risk factors.

Table 1 Rates of food insecurity in post-secondary students from extant research

Location of research	Rates of food insecurity in students reported	Source
10 community colleges in the United States (4300 students surveyed)	10 % reported going hungry; 50 % at risk for insecurity	Goldrick-Rab and Broton (2015)
Griffith University (Queensland state, Australia) (399 responses)	10.2 % food insecure	Hughes et al. (2011)
Deakin University (Victoria state, Australia) (124 responses)	18 % food insecure	Micevski et al. (2014)
California State University-Sacramento (USA) (67 students surveyed)	19.4 % food insecure	Hanna (2014)
KwaZulu-Natal (South Africa) (1083 students surveyed)	20.8 % vulnerable to food insecurity; 16.1 % serious insecurity	Munro et al. (2013)
University of Hawai'i at Manoa (Hawai'i, USA) (441 responses)	21 % food insecure; 6 % very food insecure	Chaparro et al. (2009)
University of California System (California, USA) (estimated)	25 % food insecure	Rosenberg (2015)
City University of New York (New York State, USA) (1068 responses)	40 % food insecure	Freudenberg et al. (2011)
Rural Oregon University (Oregon, USA) (354 responses)	59 % food insecure	Patton-Lopez et al. (2014)

Other causes are related to institutional structures. Meldrum and Willows (2006) note that many universities and colleges are situated in areas where low-cost grocery stores are difficult to access. Compounding this "food desert" is that, within the campus, a food monopoly created by for-profit corporations operating campus cafeterias and other food retail services means that at many campuses accessible and affordable food is hard to come by (Canadian Federation of Students-Ontario 2012). A 2012 study in Ontario found that a majority of students reported needing to purchase food on campus regularly, but that 63 % of those surveyed thought the food was expensive, and the quality poor, given the cost, the prevalence of unhealthy choices and unmet special dietary needs.

Food insecure students cope in different ways. Hanna (2014) found that if they lacked food, 100 % of students surveyed did not eat a balanced meal, 69.2 % skipped a meal (44 % did so monthly, 22 % frequently), 92 % reduced the size of the meal, and 38.5 % did not eat for the entire day. Others resorted to stealing (Micevski et al. 2014), or working additional jobs (Farahbakhsh et al. 2015; Nellum 2015), although Patton-Lopez et al. (2014) noted that additional employment while studying neither improved academic focus nor food security levels. Farahbakhsh et al. (2015) found other strategies included applying for additional student loans, using credit cards to buy food, or using campus-based food banks. Nellum (2015) reports that the number of campus food banks in the US rose from 1 in 2007 to 184

in 2015, but food banks are not good evidence of the level of the problem as they are a last resort (Abbott et al. 2015; Koller 2014).

Food insecurity brings serious consequences, including "poorer physical and mental health and higher rates of chronic conditions, including depression, diabetes and heart disease" (Tarasuk et al. 2012). However, the costs of food insecurity are more than physical and affect mental and emotional well-being (Williams et al. 2012): struggling to obtain food is a critical dimension, but struggling with institutional structures controlling access to food while feeling judged by those institutions for needing aid is worse.

For college and university students in particular, these impacts can actually undercut the entire point of sacrificing to attend post-secondary institutions. Cady (2014) extrapolates multiple studies on the consequences of food insecurity in young children and adults to college-age people, noting that food insecurity leads to lower scholastic achievement, behavioral concerns, mental health issues, poorer memory and poorer academic performance. The need to offset financial concerns through holding down jobs while going to school can also result in poor academic performance (Patton-Lopez et al. 2014). Food insecurity in post-secondary education can have long term health, learning and social outcomes, including lower GPAs (Patton-Lopez et al. 2014). Gaines et al. (2014) note that food insecurity can create greater loan and credit card debt at a time when graduates struggle to find jobs paying enough to address such debt.

Food insecurity amongst students should, given the consequences, be of concern to post-secondary administrations and deserves meaningful inclusion in any environmental justice based planning for institutional sustainability. If students cannot feed themselves, how can they participate meaningfully in greening their campus or bringing sustainability to the world, or even continue going to school when they must choose between food and tuition?

3 The Case Study

UNBC is a smaller comprehensive university offering Bachelors to PhD degrees. Located in Prince George, British Columbia, it is also a newer university, admitting its first students in 1992. Early on, UNBC committed to pursuing a sustainability mission, dubbing itself "Canada's Green University" and receiving a Bronze Star ranking from the STARS sustainability assessment program (AASHE). As of 2015, 3115 undergraduate and graduate students were registered. UNBC shares some institutional structures linked with food insecurity among students, including a location isolated from non-university businesses including grocery stores. As well, UNBC has contracted with a for-profit company for campus food services, which has an exclusionary lock on food services with the exception of a student-run pub serving meals. Campus residence units currently include kitchens, allowing students to prepare purchased food, but all first-year and second year students in

residence (including international exchange students) must purchase a meal plan with the company.

UNBC collects minimal demographic data on its students, however it likely models student population trends in Canada, where annual studies indicate that, among first year university students, the majority are female (about 2–1) and 18 years of age or younger (72 %) (Canadian University Survey Consortium 2013; Canadian University Survey Consortium 2014). In their first year, about half of the students (47 %) live with relatives, although 36 % choose to live on campus (Canadian University Survey Consortium 2013). By their third year, 47 % live independently (Canadian University Survey Consortium 2014).

About 54 % of students received financial aid in 2012–13 and 29 % of those students would not have attended university without a loan. Fewer than 4 in 10 students are typically employed, of those that are, about 3 in 10 report that their work has a negative impact on their academic performance (Canadian University Survey Consortium 2013).

4 Study Methods

UNBC was treated as a case study (Lauckner et al. 2012; Yin 2008). Case study methods examine "a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not clear" (Yin 2008: 13), and is used when examining questions of process. This methodology utilizes data from multiple sources, including situated knowledge as well as a mixed-methods approach, using both qualitative and quantitative methods.

Data collection was undertaken during the Fall Semester of 2015, using two primary methods. We began with semi-structured interviews with key UNBC informants identified both through local knowledge and through snowball techniques. These included the Undergraduate Student Society and Graduate Student Society executives, the academic staff union executives (the faculty association executives declined to participate), and representatives from the Wellness Centre, the First Nations (Aboriginal) Centre, student advisors and the director of the Women's Centre. Interview questions focused upon perceived levels of food insecurity amongst their publics as well as factors creating insecurity. Interviews were recorded and were analyzed through reviewing recordings and free coding for key themes and ideas.

Interviews results were used to develop a web-based survey utilizing both closed and open ended questions. The survey was promoted by having groups forward the survey to their memberships, an article on the study in the student newspaper, posters around the university and 4 days at a table in a central location where students could complete the survey. The survey was active for five weeks with email reminders sent out twice.

Survey questions included a range of demographic questions (gender, age, employment status or level of study if students, housing circumstances and if they had children), questions related to food insecurity and personal risk factors, as well as options for addressing community food insecurity. Questions around food security included direct self-assessments of perceived levels of food security, as well as indirect questions assessing the ability to grocery shop, time for food preparation, etc. Open ended questions allowed for discussion of reasons for concerns over food security. Other questions assessed the campus food contractor's operations. For this article, results have been analyzed through descriptive statistics, although further statistical analysis will be conducted in the future. Open-ended questions were analyzed through thematic free-coding.

5 Results and Discussion

We received 216 student responses from a total population of 3115 (2517 undergraduates and 598 graduate students), creating a response rate of 7 % (6.5 % of undergraduates and 8.6 % of graduate students). Eleven percent of responses were from international students. Factors identified as increasing risks of food insecurity are present at UNBC: 71.3 % of respondents were 25 years old or younger, 73.1 % lived off campus, although usually with a partner or roommate, and 50 % worked part time. Just over 77 % of respondents were female. Fifteen percent reported having a mental or physical disability.

When asked directly, 3 % reported being very food insecure, 6 % were food insecure and 15 % were unsure. While this suggests 9 % of students are food insecure (with another 15 % possibly at risk), other responses suggest greater levels of insecurity. When asked the reason for this circumstance, 38 % stated it was due to poverty, while 65 % said it was due to a lack of time. Thirty-seven percent experienced challenges shopping for food, and 24 % said this was due to poverty. Twelve percent had utilized an on-campus food bank at least once, although written responses suggested discomfort in so doing, either due to a lack of privacy or due to shame or a feeling that others needed the help more. The impacts of food insecurity are significant as 39 % of responding students indicated that the inability to eat well had affected their ability to study or take classes or to do their best at either, with 13 % of those respondents experiencing this either on a daily or weekly basis.

Corroborating these indicators, 39 % of participating faculty and 29 % of participating academic staff reported experiences with hungry or food insecure students. Key informant interviews also suggest a higher rate of food insecurity amongst students. Two informants noted that the majority of students they see who are food insecure are male, however, survey respondents were 77.8 % female, thus, survey results may not accurately model true levels of student food insecurity (although a slightly greater proportion of females reported being food insecure). Further, informants raised two additional concerns, the first, that students are often reticent to admit to any financial insecurity including food insecurity. The second is

an informed suspicion that many students that drop out of UNBC during their first or second year, do so due to financial crises, including food insecurity. Although anecdotal, this data hints at a higher level of food insecurity than modelled in this survey. Certainly 85 % of faculty and 88 % of academic staff believe that UNBC's undergraduate population is food insecure, while 67 and 68 % respectively believe graduate students are food insecure.

Other interviews raised the issue of the tenuousness of student security. In 2015, UNBC experienced a two-week strike by faculty. Not only were classes suspended but also on-campus student employment. The Northern Undergraduate Student Society, which runs the sole campus foodbank and supplies emergency bursaries to students, found that their bursary program, which had been substantively underutilized prior (to a point where they had stopped applying for additional funds), ran out of money within the first week while the food bank shelves were emptied daily. If circumstances are "normal", it appears many students can survive; however a two week disruption quickly caused a crisis for many. A troubling addition to this assessment is that 45 % of students in the survey reported that, in a financial emergency, they had no idea who they could or would talk with about that emergency, a serious vulnerability.

If, as is suspected, our survey results inexactly model UNBC's student population, the level of impact of chronic food insecurity coupled with an ignorance of where to turn in a financial crisis, might be significantly threatening the success of UNBC's students, a serious challenge for an academic institution both morally and in meeting its primary purpose.

As previously noted, this was a "community" research project and university staff and faculty were invited to participate. UNBC has both union (CUPE) and Exempt (non-union) support staff; both groups were invited to complete the web survey on food insecurity. One hundred and thirty one staff members, out of a possible 392, responded, creating a response rate of 33.4 %. Eighty-one percent of respondents were women and 83 % had permanent full-time positions with 67 % assessing their wage levels as medium to high against their possible salary range. Eighty-three percent were between the ages of 26 and 55. Seventy percent lived with a spouse/partner but only 38 % reported dependents for which they were financially responsible. Nine percent reported having a mental or physical disability.

Food insecurity appears to be a significant concern for UNBC's staff members. While 7 % reported being either very food insecure or food insecure (5 % were uncertain), 39 % reported that they cannot eat in a healthy way, 15 % due to poverty and 57 % due to a lack of time. These discrepancies between being willing to call themselves "food insecure" and meeting the definition of being food insecure once again suggests that our survey results may inexactly model food insecurity in the UNBC community, as does the gender disparity in respondents.

Much like UNBC's students, food insecurity appears to be compromising the ability of staff to do their best at work: 13 % reported that being unable to eat well affected their ability to do their job. Staff members are also vulnerable to challenging circumstances: 52 % reported they would not have anyone to approach in

the case of a financial emergency. Corroborating this finding is data from open-ended survey questions and key informant interviews, indicating that many staff faced financial difficulties during the lock-out due to the two-week faculty strike, suggesting that these UNBC community members may be fragile in their day-to-day financial and food security, as comments from the survey suggest:

> During the faculty strike, I could not afford food and only ate once a day.
>
> I have colleagues that are in extremely precarious situations. I have provided food to colleagues on more than one occasion.
>
> I know of at least one co-worker that was extremely worried during the job action earlier this year that she wasn't going to be able to feed her family. Although the strike is in the past, I suspect her income doesn't allow her to become truly food secure.

Fifty-three UNBC faculty members (including non-union librarians and permanent non-tenure teaching lines) out of a possible 343 completed the survey, creating a response rate of 15.5 %. Fifty-six percent were female, 43 % were male. Seventy-one percent were between 36 and 55 years old, and 17 % were between 56 and 65. Sixty-four percent were tenured or in a tenure-track position and 64 % reported being at the mid or high point of their possible salary range. Only 44 % reported being financially responsible for dependents but 67 % lived with a spouse or partner. Eleven percent reported having a mental or physical disability.

Eight percent of faculty members reported being either food insecure or very food insecure. Another 6 % were uncertain. This is a rather surprising level of food insecurity within the faculty population, given that those rating themselves as being food insecure were not sessional instructors (among the most vulnerable faculty), but in permanent positions. There was a gender component, slightly more women rated themselves as being food insecure.

However, food has other impacts on faculty members: 48 % responding were unable to eat well and 15 % said this affected their ability to perform their job. While 95 % attributed this to time constraints rather than poverty, it is the inability to eat well, rather than the cause, that defines food insecurity, therefore our research suggests a substantive portion of UNBC faculty are food insecure. A significant portion may suffer vulnerabilities similar to that of academic staff and students as 39 % reported not having anyone to speak to in a financial crisis. While faculty did not discuss impacts from the strike, their personal stability might be not as solid as conventionally assumed. Indeed this research project begins to suggest that food insecurity at UNBC is a problem extending well beyond that of the commonly studied student population.

A contributing factor to UNBC's food insecurity reality is one mentioned in the Canadian Federation of Students-Ontario study (2012), that of the monopolization of campus food sources by for-profit corporations. UNBC exists in a "food desert" and those on campus rely on campus food outlets. With the exception of the student society's pub, all food outlets on the main campus (a cafeteria, and a coffee shop/deli) are operated under contract by an international corporation. That contract restricts outside food provision in all but the student union building. Other rules restrict access and use of corporate controlled spaces, and require all first and

second year students in residences, as well as international exchange students, to be on the company's meal plan. Lineups at the coffee shop/deli reportedly restrict their use. As key informants cited concerns around limited access to inexpensive healthy food on campus, our survey assessed views on the cost and quality of campus food (excluding the student pub). Closed and open-ended responses established dissatisfaction with a food monopoly as well as with the cost and quality of the food available. Nineteen percent of students were satisfied with the food, 15 % with the cost and 19 % with the quality. Twenty percent of staff members were happy with the food, 24 % with the cost and 26 % with the quality. Twenty-two percent of faculty members were happy with the food, 18 % with the cost and 27 % with the quality. As students have fewer options, their dissatisfaction is significant.

We also assessed solutions for food insecurity at UNBC, particularly as a basis for future sustainable community food policies. Interviews and survey responses pointed to the need for more diverse, inexpensive and healthy food options on campus for everyone:

> How does UNBC want to prioritize? Ancillary Services [overseeing the food services contract] makes money, but if you want to support students other options need to be developed. If students are vulnerable, the university is vulnerable.

Informants pointed out the contradiction in the university's concern for student retention while their inability to access affordable food was driving students to drop-out. It was also noted how under the radar food insecurity is for university administration, particularly the struggle front-line workers faced in providing support for hungry students, citing bureaucratic hurdles and a lack of coordination between available assistance providers.

The survey asked for rankings of different responses to address campus food security. Among the most popular were

- expanding the Good Food Box Program (a monthly provision of 20 lb of local fresh produce for $20) including free boxes for those in need (faculty—45 %, staff—34 %, students—40 %),
- expanding the weekly on-campus Farmers Market (faculty—36 %, staff—21 %, students—27 %),
- supporting the student run coffee shops in selling take-out food items (faculty—26 %, staff—31 %, students—36 %),
- establishing a campus food cooperative (faculty—36 %, staff—42 %, students—31 %), and
- establishing a Community Kitchen (Faculty—19 %, Staff—24 %, students—36 %).

Significantly, more campus food banks was not well supported (faculty—17 %, staff—24 %, students—14 %), suggesting both the stigma of using a food bank and perhaps an interest in more effective responses. The majority from all groups (80–85 %) wanted these options available to all members of UNBC, suggesting the perception of the community nature of the food security problem.

UNBC has a significant food insecurity challenge. This research took a community perspective and by so doing, demonstrated that food insecurity is genuinely a community concern, affecting all populations on campus. UNBC's food insecurity levels are high, affecting perhaps 39 % of UNBC's students, 39 % of its academic staff, and 48 % of its faculty members. These rates are significantly higher than in the general population of British Columbia where 11. 9 % of households face some level of food insecurity (Sriram and Tarasuk 2015). While the causes vary across these populations, among students, poverty is a major factor while for faculty it is a time crunch issue, and staff suffer from both, the consequences affect the university community profoundly as 13 % of academic staff, 15 % of faculty and 40 % of students cannot perform at their best as learners, teachers or facilitators due to food insecurity. While UNBC's food insecurity rates for students fall within levels reported in other research, they are on the high end and should raise concern amongst the UNBC community.

As the food insecurity situation for university/college faculty and academic staff has not been studied before, our findings suggest both a field of future enquiry and a very profound question about why food insecurity is not viewed more commonly through a community lens. If those who teach and support students, particularly vulnerable students, are themselves vulnerable and unable to perform their responsibilities due to a personal state of food insecurity, then the mission and purpose of universities are at risk, as is their position as a moral actor within larger society.

Finally, there is the question of the relationship between an institutional community's level of food insecurity and its mission of creating and contributing to the goals of sustainability, both through its own campus footprint, through research and through the building of graduates who go out and create sustainability in the wider world. Maslow's oft-cited Hierarchy of Needs (1943), posits that, before an individual can "self-actualize", or for purposes of this discussion, care about and contribute to a greater good, their basic needs, both physiological and psychological, must be met. Hungry people cannot make the world a more sustainable, just place. If we are to teach, learn and create sustainable options, we must start by ensuring our own community of learning is a community where all can find security and something healthy to eat.

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Authors Biography

Annie L. Booth is a Professor of Environmental Studies in the Ecosystem Science and Management Program at the University of Northern British Columbia (Prince George, BC, Canada). She teaches and researches in a variety of areas including environmental ethics, sustainability, Aboriginal resource management and environmental justice. She was an inaugural member of UNBC Green University Planning Committee.

Melanie Anderson is currently pursuing an undergraduate degree in Environmental Studies at the University of Northern British Columbia in Prince George, BC Canada. She works at the University as the Market Manager for the University Farmers Market and as the Local Foods Coordinator with the Prince George Public Interest Research Group (PGPIRG) promoting local foods to students and staff and providing monthly good food box's to the campus community. She also works with the Campus Food Systems Project through Meal Exchange working on sustainable food procurement and policy changes in institutions across Canada. In her personal life she takes local seriously by committing to eating and living locally for an entire year which she shares on her blog Mel the Locavore.

Student Leadership in Sustainable Development in a Private University in the UAE—A Case Study

Kathy O'Sullivan

Abstract

Higher education helps prepare students for the professional arena, yet would appear to have few explicit training opportunities to enable students to develop personal leadership skills. This is even more evident in the United Arab Emirates (UAE), where, although there is recognition that students have much to offer in the leadership process, the idea of students as participating in campus life on a leadership level has yet to take root. How do students themselves perceive and navigate the leadership opportunities and developmental processes, or lack thereof, afforded to them at university? The research focused on a longitudinal case study, over the course of an academic year, in a private university in Dubai where data were gathered through qualitative approaches. Findings indicated perceived positive and challenging experiences as reported by the student leaders. Recommendations include fostering relationships with K-12 institutions and also developing mentoring opportunities at the university level, as student leadership is key to sustainability in higher education. These findings contribute to the growing body of student leadership literature globally, and may help stimulate research on student leadership in the Middle East, where there is currently a dearth of literature on the development of student leadership potential.

Keywords

UAE · Student leadership · Case study · Higher education

K. O'Sullivan (✉)
South University of Science and Technology of China, Shenzhen, China
e-mail: kathyos@sustc.edu.cn

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1 Introduction

A stated goal of many higher education institutions is to prepare graduates to be future leaders in the professional realm, yet there are still too few formal training opportunities to assist students in developing such leadership skills (Cress et al. 2001). Although there has been a relatively recent increase in leadership education programs, particularly in the US (Komives et al. 2011), a change in mind-set is necessary on a broader scale. Student leadership is a fundamental part of sustainable development in higher education, yet seems not to be a primary concern for many institutions (McIntosh et al. 2001).

Student leadership is also a topic of interest in school-based leadership programs. Recent research has acknowledged the need to understand the student leadership experience from the perspective of students (McNae 2011; Hine 2013). This article examines student perceptions of the student leadership experience in a climate where students are traditionally given very little say, higher education in the UAE. Their positive experiences and the challenges they face are explored. This will lead to a greater awareness of how higher education development can be made truly sustainable, not only in the UAE, but also the Middle East region generally.

2 Literature Review

Leadership models aimed at students in higher education have emerged in recent years, including the Relational Leadership Model (Komives et al. 1998, 2007), the Social Change Model of Leadership development (HERL 1996) and the Leadership Challenge (Kouzes and Posner 2002), all of which recognise the need to develop students' skills.

Given that many perceive a lack of leadership in the world today, leadership development amongst students is key to the future of society. Higher education is uniquely placed to make a difference by developing their leadership potential (Komives et al. 2011; Patterson 2012). This will ultimately lead to sustainable higher education.

3 Engaging Stakeholders

Engaging stakeholders, whether employers, alumni, families, administration, faculty, the student body, or the wider community, benefits universities (Dugan and Komives 2007). Stakeholders can facilitate the development of relationships that will improve the environment of a university, particularly if they have a voice in that process.

4 The Leadership Challenge

Kouzes and Posner's (1995) model of leadership revealed five main practices of leaders, including (a) challenging the process by engaging in meaningful projects, (b) inspiring a shared vision, (c) enabling others to act, (d) modelling the way, and (e) encouraging the heart of those they lead. This model has been used extensively in leadership development programs at universities (Kass and Gandzol 2011). Leaders are developed over time, to increase self-awareness and leadership capacity.

5 Transformational Leadership

Transformational leadership originated in the work of Burns (2003), by comparing transactional leadership (based on reciprocity) with transformational leadership (when people participate in the processes of change, leading to greater personal transformation). According to Bass and Riggio (2006), this leadership model comprises four components, namely: idealized influence, or a leader's ability to serve as a role model for followers; inspirational motivation, or motivating followers through inclusion; intellectual stimulation, or a leader's ability to encourage followers; and individualized consideration, where leaders engage in mentoring, for example. This model has since gained prominence in many higher education institutions (Northouse 2012).

6 Adaptive Leadership

Heifetz' (1994: 22) model of adaptive leadership posits that leadership is necessary for addressing adaptive challenges. Adaptive challenges, according to Heifetz, consist of "the learning required to address conflicts in the values people hold, or to diminish the gap between the values people stand for and the reality they face. Adaptive work requires a change in values, beliefs, or behavior". Leadership develops through the case-in-point method, which uses the classroom to teach and learn the issues of leading adaptive change, through instruction and reflection (Parks 2005).

7 The Social Change Model

The social change model of leadership development comprises seven interrelated core values, including (a) three individual values—consciousness of self, congruence, and commitment, (b) three group values—collaboration, common purpose,

and controversy with civility, and (c) one social/community value—citizenship (Komives et al. 2009). A change that is values-based links to Heifetz's adaptive leadership model (1994). According to Komives et al. (2009), growth as a leader occurs in the three areas of knowing, being and doing, thus lending itself to civic engagement.

8 Influences on Leadership Behaviours

Research suggests student leadership opportunities at university have not been as frequent as they could have been (Hilliard 2010; Zimmerman-Oster and Burkhart 2002). Some studies have suggested that the more hours students spend per week performing volunteer or student club/organization activities, the more likely they are as a result to show development and growth in leadership areas (Bardou et al. 2003; Fritz et al. 2003).

9 Sustainable Development in Higher Education

Sustainable development is "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (World Commission on Environment and Development 1987).

As noted by Clugston and Calder (1999), Agenda 21, adopted by the 1992 Earth Summit, states that 'education is critical for promoting sustainable development and improving the capacity of all people to address environment and development issues'. So what does this mean for a university that wishes to be sustainable? In practice, developing a sustainable educational model helps students gain a deeper understanding of the issues and motivates them to play their part.

10 Research Context

The university selected for this study is a co-educational, private university in Dubai that has approximately three thousand students enrolled. This university has been purposively selected as it is a western-style institution (where student leadership has developed substantially in recent years), where the student body comprises more than one hundred different nationalities (meaning students will bring an array of experiences from different environments). Student councils are chosen by a panel comprising faculty, administration and the Student Affairs division, after a process of interviewing, examining CGPAs and the quality of the applicants' applications and previous experience and aptitude. Given political turmoil in the region in recent years, the issue of student leadership is a particularly sensitive one.

11 Research Question

This research aimed to explore, through a case study, how sustainable educational development has affected the approach to student leadership development at a private university in Dubai. Specifically, the study traced the leadership experiences of twenty student leaders on student councils over an academic year (2014–2015), exploring the ways in which the university supported the development of these students. How sustainable development in education was affected was also examined. Three specific research questions guided this research: 1. What program of student leadership development is being followed at the university? 2. What do the student leaders experience as they participate in the university's operations? 3. How does student leadership impact on a university's sustainable development in education?

12 Method

Allowing students to explore their own perceptions of leadership learning guided the qualitative approach of this study (Denzim and Lincoln 1996). The specific nature of the research context indicated triangulation and thick description (Stringer 2008) would be achieved through a multi-layered qualitative approach (interviews, document study, field observation notes).

Twenty student council leaders were interviewed three times during the academic year. The students were either in their second, third or fourth year of study, all of them being classed as academic high achievers. Their cultural background reflected the diverse range of nationalities of the student body, as the UAE, Egypt, Jordan, Iraq, Canada, Nigeria and Russia were all represented. Eleven were the recipients of scholarships or some other form of financial aid. The document search examined literature concerning the university's approach to student leadership, such as official publications (university handbook), newsletters etc. Semi-structured in-depth interviews, each lasing between thirty minutes and an hour, allowed the participants to articulate their understanding of the student leadership experience. Each participant was assured of anonymity, to encourage forthrightness in terms of answers. Questions ranged from the participants' perception of what they thought the benefits and challenges of the student leadership experience were, to their advice they would give to the university.

The interviews were first recorded and later transcribed, with specific codes being assigned to different parts of the text. This led to a codification of data, with themes emerging as a result, a process known as thematic content analysis (Miles and Huberman 1994; Silverman 2015). Thematic fields are divided into core—and subthemes as units of analysis. Relevant quotes were integrated into these themes in order to support or refute particular findings, thereby conveying participants' views more accurately. The interviews are underpinned with findings from the literature review. Narratives were used to reflect participant experiences, to provide a forum

for meanings that describe a phenomenon as lived and perceived by the participant. By examining individual stories, their interpretations of their experiences became apparent (Boje 2000).

13 Results and Discussion

All of the student leaders interviewed consider themselves to have grown personally, academically and socially. They believe they are contributing to building to a sustainable education environment.

14 Benefits of Student Leadership

The benefits of student leadership, as perceived by the students themselves, are as follows:

1. Engendering a sense of responsibility

The belief that they have become more responsible was expressed by sixteen of the student leaders. Sophie was enthusiastic about this:

> Many students don't want to be responsible in the UAE, I think. It isn't like this in my country, so I'm glad I've had the chance to be responsible as a student council member. Others rely on me to represent them, and it helps me feel connected to the university.

It is obvious that Sophie has a sense of ownership of her portfolio, of her university, that is helping her develop as a leader. For Felipe, the responsibility extends to helping others develop an aptitude for leadership:

> It's my responsibility to train others to be leaders. I've been lucky to have mentors help me, so I need to pay it forward. I want to know that when I graduate, there will be others who are ready to lead. We need to continue the momentum, as this is what will make the university develop.

2. There is no 'I' in team

All but one of the participants commented on the importance of being part of a team. Mohamed, for example, believes that student leadership has shown him how to build a team:

> Sometimes, when there's a group, only a few people do all the work. Being a student leader has helped me to get a team together and get everyone to do their share. This is important for all students to know, and is something we will take with us when we are working.

Sally agrees wholeheartedly:

> Teamwork is important. In the beginning, some people didn't do their share, but we've had training, and now we understand that we have to work together. It's creating a new environment here.

Team-building skills are closely related communication.

3. Communication

Eighteen of the participants strongly believe they have learned a great deal about the process of communication. Abdulla says:

> I've learned about being a leader, how important communication is. As a student council representative, I have to communicate in meetings on behalf of students. I learned that sometimes it's not what you say, but how you say it. It's something I think is important in every part of my life.

Sam agrees that the whole process of communication is important for leaders to understand:

> You need to be clear about what you are communicating, but you also need to understand what others are trying to communicate. It's a responsibility, even a risk. It's a team effort. When we communicate with faculty or management, we feel like we are in this together.

Sam shows an in-depth awareness and understanding of the multi-faceted nature of communication, even that it involves an element of risk.

4. Taking risks

Ekaterina talked about how learning to deal with the unknown means she is now more willing to take risks:

> Sometimes you might want to organise something and you're worried administration won't approve. So, do you wait until the last minute, knowing there's no time to organise, or do you decide to go ahead anyway and hope that permission happens? I learned the hard way! Just go for it. I'm more likely to take a risk than before. To be better, we need to take more risks.

James concurs with such an approach, noting that

> I've learned there are no guarantees. You've sometimes got to take a risk. Sure, you might fail, but that's how you learn. If you don't take the risk, you can't have the benefit. That's how it is in education, in work, in life. I'm seeing how things are connected.

These students have learned to navigate their way through uncertainty, resulting in a high level of personal growth. The lessons they have learned could benefit the student population as a whole.

5. Greater awareness of and interest in civic responsibility

Fourteen participants have become interested in civic responsibility. For example, Badr believed that participating in campus initiatives led to a commitment to make a difference outside university:

> What really made an impression on me was the 'five days for the homeless' campaign, living like a homeless person for 5 days, to raise awareness and money. After, I thought that there had to be more I could do to make a difference outside university. Now I am doing some volunteer work. I want to do more to help my community.

Debra has also become more committed to civic engagement:

> One thing I was involved in was filling boxes with clothes for the workers in labour camps. So many responded that we had to get more boxes to fill! It opened my eyes, and I got involved in other campaigns, environmental campaigns, like with Emirates Environmental Group, to make our campus better, to think about the environment we want to live in.

What these students appear to have gained is a sense of their personal values and ethics. By engaging in the wider community, they become more adept at solving problems. A greater awareness of the environment around them is leading to participation in campaigns aimed at improving their environments.

6. Problem-solving

Without exception, all of the participants believe problem-solving to be one of the most useful skills they have learned, citing numerous examples of solving problems at a broader level. Hesham, for example, noted that:

> In the student council, sometimes you have to deal with a problem between students, where they want it to be confidential, and they rely on you to sort things out. We've been mentored in this area, and I can now use this skill at work, at home, as well as at uni. This is as important as good exam marks for me.

Training has clearly helped student leaders develop conflict resolution skills. They pass these skills onto other students, by helping them in turn with problem-solving strategies.

Badria agrees with Hesham:

> Being a leader helped me to find solutions to problems. This is something I'm using in all areas of my life. It will help me when I'm working, because what I'm learning is now more practical. Not all professors teach us practical applications, but more do it now than before.

Leadership training enables students to process issues and have better decision-making skills. Students see the links between theory and practice.

7. Understand the links between theory and practice

Seventeen students commented on the links between what they learn in class and their leadership experiences. Alain noted that:

> In Business, we study management, things like having a strategy etc. This is very useful in the student council. I recognise the scenario and then I use the strategies we learned to deal with the situation. I like it when I see that theory is real.

Zahra also uses theory to inform practice:

> I've see the links between what we study and what we do. This makes me approach my studies differently, as I now see myself really developing as a person and as a student. I can help my brothers and sisters also, so the whole family benefits.

The benefits of leadership development are significant. Students become involved in the wider community, while at the same time developing decision-making skills, and practice what they learn in a wide variety of situations (Cress et al. 2001). What, however, are the challenges student leaders may face?

15 Challenges of Student Leadership

The benefits of leadership training are clear, yet are accompanied by a corresponding set of challenges which students have to negotiate. Three main challenges emerged during this study, namely relationships with faculty, relationships with peers and balancing leadership with other responsibilities. Each of these will be discussed in turn below.

1. Relationships with faculty

All of the participants mentioned relationships with faculty as being the main challenge they faced. As Ilaria commented:

> Some professors work with students, mentoring them. However, many don't seem to want to do this. This means all students go to the few professors that want to help, so these professors have lots of work to do. I know we have to do things for ourselves, but we need to be shown *how* to be leaders for the future.

Vladimir concurs, adding that:

> In this country, professors usually stay at a university for a few years, and then move. Usually these are very good professors, so we need more professors who are our role models, who will work with students and make a difference. Student Affairs always try to get the professors more involved, but it's really hard.

Perhaps faculty need a reciprocal arrangement as an incentive to mentor students. Students mentioned they would be happy to help faculty with technology-related issues, or with organising departmental events. This already happens on an informal level, so perhaps it could be expanded.

2. Relationships with peers

Seventeen participants remarked that their role as student leaders has affected their relationships with peers. An example of this was given by Aida:

> Sometimes other students have unrealistic expectations. They think that we have more power than we do. Other students think we are too close to administration and always take their side over students, but we just try to look at both sides. Before this, I didn't understand how difficult it can be for administration too.

Hikmat agrees with Aida, adding:

> Sometimes it's hard to know who to trust, as some students pretend to be friendly with you, they think it will get them what they want. It's tough sometimes, but I have to say most students are great. Anyway, developing these relationships is an amazing experience.

It seems some student leaders are dealing with ethical considerations and how to make their peers aware of such considerations, which will help them understand the importance of ethics in general.

3. Balancing leadership with other responsibilities

Balancing a range of responsibilities was seen as challenging by fifteen participants. Darius elaborated as follows:

> Having a high CGPA is important to me, and it suffered the first semester I was in the student council. However, after training, I'm now much better at time management, and so far this semester, it looks as if my CGPA will rise. It's been a good lesson for me.

Noora, on the other hand, found that she couldn't do it all:

> Before I joined the student council, I was involved in so many things. I thought I would be able to manage it all, but being a leader takes up a lot of time, and, if you want to do a good job, you can't do everything. I've learned to prioritise. I don't belong to so many clubs now, but the ones I do belong to, I give 200 %.

What emerges is that both the benefits and the challenges that student leaders have encountered have led them to have a better understanding of themselves and others. Leadership skills have been developed that have improved community relations. Encouragingly, many student leaders wish to develop leadership skills in their peers.

16 A Policy Question of How to Foster Sustainable Development

As the UAE education market shifts its focus from the national stage to a more global one, the policy problem now facing universities is how to have a competitive edge within the market. For truly sustainable education development at universities

in the UAE, policy makers need to be more aware of and responsive to the local context, by perhaps recruiting the wealth of existing student talent.

As the university is a microcosm of the community at large, involving students in its operations and planning would help cement values once students enter the professional milieu, thus making the education and work environments more sustainable. Engaging students in curriculum design would provide further teaching and learning opportunities. Students are a key university resource for building a sustainable university community.

Although students begin some projects as classroom-based ones, they quickly learn that economic and social relationships are key to success. They develop working relationships with administrators to understand how the university environment functions. As students in this study commented, they feel invested in *their* campus and its development, as stakeholders.

Students in this study are motivated and actively seek opportunities for development, reflecting other studies (Connors et al. 2006; Kouzes and Posner 2002). Increasing environmental awareness has resulted in partnerships with local environmental organisations. This study finds that participation in student organizations develops student leadership competencies and skills. Developing leadership skills helps students serve as agents of positive change and sustainable university development.

A more interconnected, multidisciplinary approach will be required, thus enabling the university to become a 'learning organization' (Orr 2002: 31). Consulting a wide range of stakeholders (employers, parents, government bodies, accreditation agencies, faculty and students) becomes central to the development of a more sustainable campus. Students will be more engaged citizens of their university and local community.

Although higher education is ideally placed to create sustainable development in education, the taking of risks that students in this study mentioned seems to be difficult for many institutions. Perhaps the underlying reason for the risk-averse climate on many campuses is that, in order to create a sustainable campus, what is required is not only environmental initiatives, but a much deeper change, a shift in the culture of higher education itself.

17 Recommendations

These findings support other studies that believe in the long-term advantages of leadership development (Patterson 2012). The successful results of the student leadership experience need to be disseminated, perhaps through social media of and university website updates. Student leaders in this study are increasingly being supported by faculty and administrators, leading to collaborative sustainability and social responsibility initiatives.

Developing mentoring opportunities for students was mentioned by every participant in this study. Faculty mentoring emerged as the most popular form of mentoring, closely followed by peer-mentoring. These relationships help students develop over the course of their university studies, and older peers can help develop younger students. It is evident that students could benefit by receiving explicit leadership training in the classroom.

Another avenue to explore is fostering relationships with K-12 institutions, which would facilitate the student leadership process in many ways. First, peer-mentoring of younger students would create a bridge between the K-12 system and higher education. Secondly, it would facilitate the orientation of new students at university. Younger students would have role models. Thirdly, creating a network of relationships could lead to student leadership conferences on school and university campuses. The earlier student leadership development begins, the more sustainable it becomes.

Finally, forming partnerships with other organisations, both local and regional, will be integral to the development of a more sustainable higher education model. The classroom application of such partnerships would involve a curriculum that has a greater focus on inquiry-based learning, relating more to the university campus as well as the wider community.

18 Conclusion

In the Middle East, a top-down education reform is taking place at a rapid pace. But what does this mean for the sustainability of an education institution, with more attention seemingly placed on exam statistics than the quality of education? The learning environment is often more complex than reformers are aware of.

Student leaders in this study exhibit personal growth, maturity and a commitment to civic engagement. Is this not what we all wish for university students? The resiliency shown by the students in this study shows how developing student leadership is a worthwhile goal, one that needs to have more attention paid to it.

What has emerged is that mentor role models are central to student leadership development. A sustainable campus requires a move towards more collaboration and cooperation. Faculty will also need to be supported in this endeavour, not just students.

This study is encouraging to proponents of student leadership, demonstrating that a combination of explicit (classroom curriculum, leadership programs) and implicit (mentoring opportunities for engagement) leadership instruction will promote personal and academic growth in student leaders, thus paving the way for future societal success.

Sustainable university development necessitates support for student leadership initiatives. In Dubai, this is serving as an agent of positive change at both the classroom and university levels. These students have achieved credibility, which is,

according to Kouzes and Posner (2002), one of the most important features of leadership. To believe in the message of sustainable university development, one has to believe in the messengers, and who better than students to get the message across?

Appendix 1: Questionnaire Used in Interview 1

1. What program of student leadership development is being offered by the university?
2. What do you understand your role to be in this program?
3. What leadership skills are you being taught?
4. Are there any activities in the classroom that you would describe as leadership activities? If this is the case, why would you describe them as examples of leadership?
5. What do you think your biggest challenges in leadership might be over the coming year?
6. What do you think will be the biggest benefits of your leadership training over the coming year?

Appendix 2: Questionnaire Used in Interview 2

1. Can you describe your experience of the opportunities and activities for leadership in this program?
2. What do you, as a student leader, identify as the main benefits from your participation in the student leadership program so far?
3. What do you, as a student leader, identify as the main challenges from your participation in the student leadership program so far?
4. What do you observe as the limitations of the way the university currently approaches student leadership development?
5. What are you learning from the other students in leadership positions?
6. Do you see any connections between what you are learning about leadership outside the classroom and what you are experiencing in the classroom? If you do, can you describe them?
7. If you don't see any connection between what you are learning about leadership outside the classroom and what you are experiencing in the classroom, can you explain why you feel there is no connection?

Appendix 3: Questionnaire Used in Interview 3

1. What have you learned about leadership from being a student leader?
2. What insights do you have after having participating in the leadership process?
3. You spoke earlier in the year about what you thought the challenges might be. Were you right about these challenges? What was similar to what you expected and what was different? Why was it different?
4. How has participating in the leadership process helped you understand what you were taught in your formal training?
5. How would you adapt the training that you have received so that it can be used more in the classroom?
6. In what ways do you believe the university should adapt or change its approach to student leadership for student leaders?
7. In what ways do you believe the university should adapt or change its approach to student leadership in order to help the university?
8. At the end of this year, looking back on everything that has happened, do you have anything else to add about being a student leader or the student leadership program at this university?

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Author Biography

Dr. Kathy O'Sullivan has transitioned seamlessly from Europe (Ireland, UK) to the Middle East (Egypt, Oman, UAE) to Asia (Japan, China), inspiring students and colleagues along the way, and serving as a mentor to women in the field of education. She has worked in colleges and universities,

in K-12 education and also as a consultant to government bodies and the private sector. Kathy has published internationally and has presented her multidisciplinary research at universities including Harvard, Cornell and Berkeley. In addition, she has collaborated on a number of children's books, with the aim being to encourage children to read more in the digital age.

She has served in a number of roles, including executive director of student services, registrar, curriculum director, Chair of English and head of quality assurance. Currently, she serves as director of the Center for Language Education at South University of Science and Technology in China, the first non-Chinese national to hold a senior management position at the university.

Creating Change for Sustainability in Universities in Australia, One System at a Time

Julie Davis and Jo-Anne Ferreira

Abstract

Higher education should be advocating for future citizens to engage in creating a more sustainable world. Teacher education, however, lags behind in building the capacity of 21st century teachers to facilitate such a transformation. This chapter discusses a decade-long Australian research program that has agitated for change using systems theory to build teacher educator capacity in education for sustainability (EfS). The program works to achieve change across the whole teacher education system, thereby overcoming many challenges inherent in the small-scale, fragmented initiatives that are typical in higher education and teacher education. Through collaborations between teacher education academics, policy makers and representatives from professional and non-government organisations, the program has effected change for sustainability through new policy directions, curriculum initiatives, and leadership capacity-building for EfS. Within universities, particularly, the program has engaged change agents at all academic levels, with different EfS expertise, and across disciplines. Reports, papers, case studies and a guide on using systems change are specific outcomes of the research program. A national network of EfS teacher educators continues the collaborations. Drawing on this example of academic engagement with sustainability in a discipline area that has been slow to engage, this chapter offers a theoretically robust way to scale up sustainability across the whole of a university.

J. Davis (✉)
Early Childhood Education, Faculty of Education, Queensland University of Technology, Brisbane, QLD 4059, Australia
e-mail: j.davis@qut.edu.au

J.-A. Ferreira
School of Education, Southern Cross University, Southern Cross Drive, Bilinga, QLD 4225, Australia
e-mail: jo-anne.ferreira@scu.edu.au

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Sustainability · Systems change · Education for sustainable development · Universities · Teacher education

1 Introduction: Higher Education, Teacher Education and Sustainability

Higher education institutions have an unavoidable responsibility to place education for sustainability (EfS) at the heart of their concerns (Gale et al. 2015) and should be advocating for future citizens to engage in creating a more sustainable world. Yet, the practice of embedding 'higher education for sustainability' (HEFS) into university courses and programs has encountered significant implementation barriers (ALTC 2010; Adomssent and Michelsen 2006; Moore 2005; Sterling 2014). This is despite the fact that many higher education institutions around the world have committed to embedding sustainability as a strategic initiative into core activities and despite international impetus from, for example, The United Nations Decade of Education for Sustainable Development 2005–2015 and a multitude of international declarations. These include, since the early 1990s, the Talloires Declaration of University Leaders for a Sustainable Future (1990), the Swansea Declaration (1993), and CRE Copernicus Charter (1993), and more recent initiatives such as the International Green Gown Awards, initiated in 2004. Indeed, many institutions have built significant research profiles and capabilities around sustainability-related research and have embraced, quite enthusiastically, campus greening initiatives, such as reducing energy and water footprints, constructing iconic 'green buildings', reducing waste and improving recycling efforts. Our concern, however, is that reshaping Higher Education (HE) curriculum towards sustainability has been a much harder task. The voices that speak for sustainability education remain few and are often marginal, lost in, for example, a seemingly global fixation with STEM (Science Technology Engineering and Mathematics) education (Freeman et al. 2015) as offering the best way forward for universities and societies to meet and overcome future challenges to environmental sustainability.

With such poor focus on reorienting university curricula to sustainability, it is little wonder that specific disciplines often fail to engage with EfS in their programs and courses. In this chapter, the focus is on sustainability within teacher education faculties and departments in higher education institutions, and specifically on pre-service teacher preparation programs. As Stevenson et al. (2015) argue, "threats to the wellbeing of current and future generations brought about by disruptions to social and ecological systems highlight the urgent need for schools and teachers to deliberately engage with educational strategies aimed at [embedding] sustainability issues" (in press), with recognition that pre-service teacher education provides an accepted strategy for ensuring that future teachers "develop the knowledge,

understanding, values and skills necessary to embed education for sustainability (EfS) into their teaching and learning practices" (in press). However, embedding EfS in teacher education has been identified as a neglected or ad hoc area of practice and scholarship (Ferreira et al. 2014a, b; McKeown-Ice 2000; United Nations Educational, Scientific and Cultural Organisation [UNESCO] 2009).

Stevenson et al. 2015 note that EfS initiatives in teacher education have mostly occurred, to date, through relatively short-term professional development in education for sustainability for pre-service education academics—either individually, or in small groups (Ferreira et al. 2014a) or, more commonly, arising from the particular interest and/or dedication of individual academic staff members within their own pre-service teacher education institutions (Ferreira et al. 2015). Evidence suggests that such superficial—though well-intentioned—efforts are most likely the case in other faculties and departments within universities. Research, both internationally and in Australia, indicates that such limited efforts do not adequately prepare teachers for teaching education for sustainability in schools (Miles et al. 2006; Ferreira et al. 2014a, b; Boon 2010). Indeed, in the Australian context, recent research identifies that around 80 % of teachers are either unaware of education for sustainability or do not understand what it is, and that only 2 % use EfS teaching practices in their classroom (Australian Education for Sustainability Alliance [AESA] 2014).

As has been noted by several authors with an interest in educational change (Fullan 2013; Hargreaves and Shirley 2012; Frost 2012; Tom 1997), sustaining curriculum change within education institutions is notoriously difficult. The loss or relocation of key champions for education for sustainability in teacher education, a range of contextual constraints such as the increasing publication and teaching demands on teacher education academics (Wergin 2007), an ever-expanding casualized academic workforce, and a constantly changing policy environment in pre-service teacher education have resulted in fragmented and poorly planned EfS projects (Russell et al. 2001; Steele 2010; AESA 2014), all of which impact on engagement with, and enthusiasm for, further change initiatives. Additionally, as McNamara (2010, p. 49) argues, curriculum change is difficult because teacher education institutions are "loosely coupled systems with a unique culture of collegial, bureaucratic, political, and anarchical systems and values" (Ferreira et al. 2015, p. 195).

In recognition of such constraints, the authors of this chapter assert "that embedding EfS in pre-service teacher education requires a more coordinated and coherent system-wide approach" (Davis et al. 2015, p. 10). This chapter draws on the reports, chapters, papers, case studies and an implementation guide that these authors have produced over the past decade that report on and discuss initiatives aimed at changing the whole of the teacher education system rather than small, piecemeal components. In so doing, the change program has sought to go beyond simple adaptations or variations of content and courses that 'fit in' with existing educational structures, objectives and processes, instead, advocating for EfS as a core focus and activity of teacher education curriculum policies and practices. For this to occur, deep and wide transformative curriculum change in how teacher

education is implemented is necessary, rather than adaptive responses that are seen as shallower and narrower (Ferreira and Davis 2015).

2 The Purpose of Our Research: Systems Change for Sustainability in Teacher Education

In an effort to bring about such deep and wide changes in how teacher education responds to sustainability, a research program using a systems approach has been established in Australia. From this program has developed a Systems Change Model (Ferreira and Ryan 2012), based in systems theory and systems change (Capra 1997; Sterling 2004) to build teacher educator capacity in education for sustainability within Australian universities. We believe there are opportunities to be shared and lessons to be learned from this decade-long change program that are relevant to other disciplinary areas within higher education. Additionally, there may also be pointers to how all universities might systemically transform their sustainability policies and practices in relation to greening the curriculum. At the core of this approach is the necessity to overcome the many challenges inherent in the small-scale, fragmented initiatives that are typical in higher education and teacher education. Contrastingly, the process works to achieve change across multiple systems and sub-systems within a faculty's or university's education system in collaboration with those outside the HE institutions who also have an interest in creating change for sustainability.

In this systems change program, collaborations between teacher education academics from within and across universities, along with policy makers and representatives from professional and non-government organisations such as teacher registration and employer groups, were brought together to effect change for sustainability. This has led to renewed policy directions, stronger EfS curriculum initiatives, and leadership capacity-building for EfS amongst teacher educators. Within the participating universities, the program has engaged a new set of change agents for sustainability at all academic levels, with different amounts of EfS experience from 'old hands' to newcomers, and from across a wide range of disciplinary backgrounds. The changes within the teacher education faculties/departments also directly impacted other disciplinary fields within the universities and, in some cases, connected with—often for the first time—longer-running campus greening programs and initiatives.

A key part of the systems change program was bringing together EfS leaders and potential leaders in teacher education from a number of universities that were somewhat connected through their geographical locations (the north-eastern part of this large continent). This 'coming together' encouraged change agents for sustainability to draw strength and ideas from each other in support of institutional HE change, and helped overcome the isolation many teacher education academics have felt working within their own teacher education organisational units. Thus, cross-university teams have now been working over the last decade to mainstream

and embed sustainability within Australian teacher education curriculum using the Systems Change Model (Ferreira and Ryan 2012) that has developed from this program. This is a participatory system-wide model aimed at facilitating change across a whole system by building partnerships that include higher education institutions (primarily teacher educators and students, but not exclusively), teacher registration authorities, teacher employing organisations, teacher professional associations, non-government organisations with an interest in sustainability and EfS, and government departments of Education and Environment. The strategic goal of this approach is for change to occur concurrently across a range of policy-to-practice 'levels' within a pre-service teacher education system, including governmental policy, accreditation and registration standards, course provisioning and teaching and learning processes (Ferreira et al. 2015). Its premise is that the deep and long-lasting embedding of EfS in teacher education requires broad engagement with, and the strong participation of, key agents of change *across* the teacher education system, in conjunction with active and deep participation *within* the system (Davis et al. 2015). It must be emphasised, however, that the model does not offer 'a one size fits all' approach to embedding EfS into a teacher education system. Indeed, one of its key strengths is that its application is context-driven, as is explained in the three case studies that come later in this chapter.

3 The Systems Change Model and the Systems Change Research Program: Theoretical and Practical Aspects

Systemic inquiry is a particular means for facilitating movement towards social learning that is understood as concerted action by multiple stakeholders in situations of complexity and uncertainty (Ison et al. 2007). A characteristic of systemic inquiry is that it has the potential to orchestrate practices across space and time which address an issue of social concern—such as sustainable development within teacher education—when it is unclear what would constitute an improvement. It builds on and extends on Churchman's (1971), Checkland's (1981, 1993), and others epistemological assumptions about human systems as emergent systems where reality is the creative construction of human beings (Jackson 1991), and social reality is the construction of people's interpretations of their experiences (Flood 2001). Sometimes referred to as 'soft systems thinking', this approach generates and works with an evolving appreciation of people's points of views and intentions. Flood further explains that, in soft systems thinking, authentic understanding of any action context requires participation of all stakeholders, that is, all the people involved in taking action as well as those affected by the actions. This can only be achieved, he states, if people enter into an action context as both actor and researcher. Hence, there are very strong parallels between systems methodologies and action research, and this explains why, as action researchers, our team was attracted to systems change literature.

As has been mentioned, cross-university teams have been working over the last decade to mainstream and embed sustainability within Australian teacher education using what was first called the Mainstreaming Sustainability Model (Ferreira et al. 2007), later renamed the Systems Change Model reflecting its evolution. The model combines the strongest features of participatory action research with a whole-of-system approach in order to concurrently initiate change across the whole system (rather than within just one sub-section i.e. one teacher educator or one university), through deep, meaningful, but flexible engagement with many participants. The premise of this approach is that deep and long-lasting change in teacher education requires broad engagement with, and the strong participation of, key change agents across the teacher education system, as well as active and deep participation within the system. In sum, this approach aims to ensure that multiple levels and contexts within the system are aligned in their efforts to work towards sustainability, thus overcoming the fragmented and small-scale achievements that have typified past efforts. To date, there have been 5 stages in this teacher education systems change program (Table 1):

When taken collectively, this 10-year program has revealed a range of theoretical and practical processes and strategies that have enabled EfS to become more embedded within pre-service teacher education programs in Australia, and one could argue that the process is now unstoppable. In particular, the change agent participants within faculties and other organizations that impact on teacher education have been able to engage productively in building capacity for embedding EfS in pre-service teacher education at individual, institutional, and state levels, and increasingly at the national level. Collectively, the program's multi stages have provided a system-wide framework that offers a range of context-specific strategies, exemplars, insights and shared resources that can serve as a model for other faculties and HE institutions wishing to implement EfS in a systematic and coherent fashion (Stevenson et al. 2015).

4 University Case Studies Snapshots

To provide further explanation of how this systems approach has functioned, the chapter now offers three snapshots, drawn from the seven case studies that were developed from the HE institutions involved in stage 4 of this systems change program. These serve to capture critical context-based experiences and the diverse ways in which the Systems Change Model was used to embed sustainability within the pre-service teacher education faculties/departments of Australian universities.

4.1 University A: Changing the Curriculum

University A's case study documented a regional, multi-city university undergoing significant change as it sought to position itself as a 'University of the Tropics' with

Table 1 The 5 stages in the 'mainstreaming sustainability into teacher education' project

Stage and years	Key attributes
Stage 1 (2006)	An international review of initiatives used to facilitate change in teacher education identified 3 main approaches (resource development i.e. kits, action research and whole of system). A new approach—the mainstreaming sustainability model—was proposed that uses the best features of these in combination
Stage 2 (2007–09)	The model was piloted in two of the eight states and territories of Australia—Queensland (5 teacher education institutions) and the Northern Territory (2 teacher education institutions). Using action research as its methodology, the pilot built on and supported existing informal teacher education networks of academics and professionals with an interest in EfS, thus strengthening communication across teacher education faculties and departments, and expanding the range of people and organisations that directly or indirectly impact on the work of teacher educators
Stage 3 (2009–10)	Replication of the pilot in two other locations—New South Wales and the Australian Capital Territory—identified five key factors that strengthened change towards sustainability in teacher education programs. These were: collaboration; developing a shared vision/ethos of sustainability and sustainable practice; connecting up existing EfS content and practices; using experiential and active learning processes; and creating opportunities for integrated programs within teacher education
Stage 4 (2012–13)	This stage involved a state-wide systems change process (this time involving all universities that have pre-service teacher education faculties or departments in Queensland) to further enhance capacity for change across the Queensland teacher education system; the development of multi-site case studies for each of the universities; and testing, refining and extending the Model. Additionally, as wider interest in the systems change process was gathering momentum, a national network of teacher educators with an interest in EfS was initiated by bringing representatives from each of the other Australian states to the final meeting of Stage 4 participants in Queensland. They were given a small amount of funds to identify teacher educators in their own states who wished to network
Stage 5 (2014–15)	Drawing on the emerging network, a series of state-based workshops with teacher educators for sustainability were held across Australia in May 2015. At these meetings, the systems change research project and the re-named systems change model were presented and discussed. These meetings served to further consolidate and strengthen the national network

an explicit interest in sustainability issues (Stevenson et al. 2014a, b). This was evidenced during 2009–2011, for example, when as part of a university-wide Curriculum Refresh Project, the Education department of the university adopted a whole-of-school approach to embedding EfS in its Bachelor of Education (B.Ed.) program. This involved embedding sustainability more deeply than previously within a core education subject (Early Childhood Education and Care) as well as the development of two new sustainability subjects, including a dedicated core subject (Foundations of Sustainability in Education and Environmental Education for the Tropics). Specifically, changes resulted in engaging early childhood and primary

pre-service teachers in EfS through innovative pedagogy assessment and the use of online technologies; promoting early childhood EfS pedagogical content knowledge through learning activities that reflected the Australian *Early Years Learning Framework* and *Queensland Kindergarten Learning Guidelines*; and revising and reshaping a sustainability elective to embed education for climate change.

In making these changes, University A's curriculum project identified the challenge, oft repeated in the literature, of bringing EfS into 'core' curriculum business. In particular, it identified the importance of professional development for teacher educators to overcome the lack of sustainability knowledge, skills and dispositions in graduate teacher professional standards. These skills, dispositions and knowledge, when they exist, provide a policy lever for Australian universities to embed EfS within their teacher education programs (see Thomas et al. 2013 for more on the place of graduate learning outcomes in sustainability as a lever for guiding student learning about sustainability). In addition to the changes to teaching and learning around sustainability and EfS, an unexpected outcome of involvement in the systems change project was that it also provided a pathway for the stimulation of research into pedagogical practice, curriculum innovation, and student engagement to support EfS.

4.2 University B: Policy Change

University B's Education department is in a large, established university that has provided teacher education programs since 1945. At the time of the systems change project, over a 1000 students were enrolled in a suite of undergraduate programs with an education focus. This case study snapshot illustrates the importance of engaging with the university's own hierarchies and existing committees in the promotion of EfS. As a result of her engagement in the systems change program, the key change agent at University B was invited to join the pre-existing Teaching and Learning Education for Sustainability working party, a group tasked with developing a proposal for embedding sustainability into all of University B's curricula for consideration by each Faculty's teaching and learning committee. The proposal promoted strategies such as the inclusion of EfS principles in the University's graduate attributes, development of a web portal of EfS resources, consideration of EfS during department and discipline reviews, creating sustainable teaching spaces, and collating elective information related to sustainability. The response to the working paper's proposal within the faculty in which Education resides showed preference for the development of initiatives to address EfS at the department level to encourage greater ownership and therefore greater momentum to enact education for sustainability. Overall, the recommendation to embed sustainability into the University's graduate attributes was supported by the Deputy Vice-Chancellor for Teaching and Learning and a university-wide proposal has now been made.

A central outcome of this institutional approach was that education for sustainability now has a clear presence within Education programs in this university. Furthermore, there have been ongoing discussions, surveys, interviews and inclusion of education for sustainability resources in Education's weekly updates, and sustainability-focused morning tea gatherings. Such formal and informal practices have brought sustainability issues to the forefront of Education's consciousness whereby, from its more visible position, there is greater scope for further action to address education for sustainability within teacher education and the university more broadly.

4.3 University C: Student Engagement

University C is a large capital city university spread across three campuses. Its Faculty of Education is one of Australia's largest providers of undergraduate and postgraduate education for teachers, and is recognised as one of the top three Australian Education faculties in research. Within this faculty, participation in the Systems Change for EfS program and use of its Model focused on raising awareness of EfS and building capacity for teaching and learning about EfS amongst both teacher educators and pre-service (student) teachers. In regard to the latter, for example, a group of student teachers become directly involved in project activities, forming a cross-institutional committee to promote EfS as a key student concern. Together, these student teachers created a Student Charter, *Embrace, Embed, Empower: Call to Action on Sustainability by Pre-Service Teachers* (Ferreira et al. 2009, p. 69), using Facebook as the means of collaborating, learning and communicating. They also participated in a number of project events including a *United Nation Australia Conference* and a *Patches of Green Forum* that was organised as the means of delivering the Student Charter to the Queensland Minister of Education. The participation of student teachers in various events illustrates the power of engaging students in advocacy work for EfS within the faculty and within the teacher education sector more generally. This is important because, as the teachers of tomorrow, these student teachers gained new knowledge about sustainability, developed collegiality and ongoing relationships with each other and with academics, and strengthened their capacity to continue to advocate for EfS in their courses and classrooms (Ferreira et al. 2009).

Over time, as a result of continued lobbying, presentations and ongoing dialogues that began with the Systems Change for EfS program, sustainability and EfS have become a trans-disciplinary theme embedded into faculty teaching, learning, and curriculum and research strategies. A post-graduate research niche in EfS has developed and there is a growing number of teacher education academics who feel comfortable embedding EfS into their specialisms, including the Arts, Literacy, Social Sciences and Science.

5 Lessons Learned and Further Opportunities for Teacher Education and Sustainable Development

A significant outcome of this systems change for sustainability research program is that the collective efforts of the teacher education change agents within individual universities have led to changes in the way EfS is embedded across individual faculties and departments and also within teacher education more broadly, at both the state-level and increasingly at the national level. The Model that is at the core of the program began by identifying those key individual agents of change with the capacity to advocate for EfS, and those key institutions, organizations and structures that comprise a teacher education system (e.g., Heads of Schools/Faculties, academics and student teachers, curriculum committees in teacher education institutions, teacher registrations authorities, employers, and the like). Our experience is that 'getting the right people' is vital. Even if they may not come into the role as an expert in sustainability or EfS, their capacity to learn and to grow into the role, advocate for EfS, and bring others along with them is essential in creating systems change (Ferreira and Davis 2015). Building foundations for embedding EfS in teacher education is further assisted "by making connections to current structures, policies and programmes that support EfS and/or being opportunistic in taking advantage of changing circumstances" (Stevenson et al. 2015, in press). In other words, systems change agents need to be willing to learn and lead, be good networkers, and have sound knowledge of policies and structures which they can use to advance their change agent efforts. Further, results of this systems change research program suggest that the Systems Change Model contributes to building capacity for change at multiple levels of a system. At the level of the individual, participation in this program has led to a range of innovative teacher education approaches and strategies across a significant number of universities that aim to assist academics to embed EfS into teacher education. This is regardless of their experience with EfS, or as an academic, or their content specialisation.

6 Implications for Universities

The Systems Change Model discussed in this chapter has encouraged inclusive and systemic approaches to building capacity for embedding sustainability, thereby encouraging a shift away from the fragmented approaches that have traditionally pervaded teacher education and higher education. Over the years, our research program has provided a range of context-specific case studies, insights into using a systems approach over a number of iterations, and a large range of practical resources for other teacher education departments to use to guide their change processes. Having had some success within teacher education, we now see that there are opportunities to extend the use of the approach to other faculties, disciplinary groupings, and, indeed, to whole universities. To this end, we encourage others to access and apply our publicly-available materials that may offer starting

points or ideas to guide ongoing work in this challenging arena within higher education.

Further, as researchers, we welcome opportunities to extend on, and critique, our efforts. Australia's university system, for example, is comprised of a relatively small number (about 40) of quite homogenous universities in structure and outlook, and largely funded at the national government level. While there is competition amongst institutions, universities are more like each other than different. It would be of interest to see how our approach plays out in contexts where universities more vigorously compete for students, and where private fees contribute substantially to a university's funding base. How well do our resources fit a range of international contexts? Would inter-university competition, for example, undermine the cooperation and sharing that a systems approach demands?

7 Conclusion

It is hard to imagine that the societal changes required to create sustainable futures will occur without the leadership of higher education institutions around the world (Haigh 2005). And, while in higher education there is now increasing interest and sometimes debate—not before time—about their leadership for sustainability role in education (Scott et al. 2012), the sector as a whole continues to be underwhelming in its response. Fortunately, new opportunities and policy drivers are emerging that may offer renewed impetus for the engagement of the higher education sector in leading sustainability education. In particular, UNESCO's (2014) 'roadmap' for implementing its Global Action Plan (GAP) on ESD over the next five years (2016–2010) offers a possibility. Priority Action Area 3, in particular, is focused on 'Building capacities of educators and trainers', and advocates for ESD to be integrated into faculty training in higher education institutions to enhance capacity in teaching sustainability issues, conducting and supervising solution-oriented interdisciplinary research, and informing policy-making on ESD and sustainable development' (p. 35). Further, the roadmap includes the considerable challenge for higher education institutions to develop 'whole institution' approaches' to embedding sustainability. This calls for systemically reorienting universities' teaching, learning and curriculum practices and policies for sustainability, an overdue addition to strengthening their campus and facilities' sustainability management practices which many higher education institutions see as the endpoint of their sustainability commitments. With the elaboration of this teacher education systems change program in Australian universities, we believe we are able to offer a theoretical and practical way forward as universities' grapple with the demands and complexities of changing their current rhetoric about sustainability into reality within the core business of higher education teaching and learning.

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Financing the Transition for a Sustainable Campus: Experiences from Brazil

Bruno Allevato and Suzana Kahn Ribeiro

Abstract

Financing projects can be considered as one of the biggest problems to reach an environmental sustainable university. Even with several successful cases spread out around the word in Higher Education Institutions, the administrative, spatial and academic heterogeneity of them, difficult the use of these examples as study case. Environmental management programs it is still in early stages in Brazilian university campus and if we consider the sustainable campus development as research field, few information exists; only few papers can be found about Brazilian cases. Therefore, this paper focus on financial aspect of sustainable campus in Brazil. In this regard, initially the paper presents three examples of successful sustainable university financing system—Green Fund UFRJ; Environmental Management System UNISINOS; and, Environmental Plan UFLA, discussing their methodology and suggesting different approaches, and then assess possible tools to planning future action and monitoring their results to increase the university commitment to the university sustainable project.

Keywords

Brazilian University · Sustainable campus · Financing projects

B. Allevato (✉) · S.K. Ribeiro
Green Fund-Federal University of Rio de Janeiro, Paulo Emídio Barbosa street, 485 1o floor Bloc 8 lote C Ilha do Fundão, Rio de Janeiro, RJ, Brazil
e-mail: bruno.allevato@fundoverde.ufrj.br

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1 Introduction

The project financing process is a critical issue in order to succeed in transforming universities campuses into sustainable environments (Velazquez et al. 2006; James and Card 2011; Huyuan and Yang 2012). This issue is increasingly addressed directly or indirectly on papers or on books (Weisbord et al. 2011; Indvik et al. 2013; Lavey 2015). Moreover, as it is a specific subject related to each university, this theme can also be discussed throughout information at universities reports (e.g. UC Annual Report on Sustainable Practices 2015. Inspirations and Aspirations—UBC Sustainable Strategy 2006–2010. Sustainable Project Fund Annual Report MCGill University 2015). All these documents compose a wealthy supply of information for analysis of new possibilities on financing projects and sustainability programs at universities around the world.

Nowadays, there are different sustainable project finance models available, which to some extent demonstrate a reflection of the plurality of Higher Education Institutions (HEI) and diverse forms of organization, management and behavior of university community (Indvik et al. 2013). In Brazil, there are more than 2300 HEI, divided into Universities, Colleges and Federal Institutes of Education; however, despite the great number of HEI and the increasing discussion on the theme of sustainability and its application at universities, cases of sustainable programs at Brazilian universities are difficult to find (Brandli et al. 2015).

There are few articles approaching the issue of sustainability at the university environment in Brazil too. Most of these articles highlight at how Brazilian universities focus their actions in the recycling field as well as how these actions are made in a decentralized and punctual way (Marco et al. 2010; Vaz et al. 2010; Viegas and Cabral 2013; Brandli et al. 2015).

Nevertheless, some successful efforts can already be seen (Tauchen and Brandli 2006; Marco et al. 2010). Yet, the critical issue faced by HEI distributed worldwide and by HEI in Brazil is the financing of projects and programs. It is therefore crucial the existence of a financing structure to assemble the creation and development of sustainable programs at the universities in Brazil.

The present paper was developed into three stages. The first stage presents three universities that have implemented sustainable initiatives on their campuses, how these three universities have different ways of financing their own sustainable programs and why these different programs can be considered successful. The second stage discusses the possibility of replicating these initiatives at other HEI in Brazil, in addition addressing other options that have been successful abroad and its application in Brazil. Finally, the last stage presents the conclusion on the issue and advancement prospects of sustainable projects studies and applications on campuses at Brazilian universities.

The universities selected to the present work were Federal University of Rio de Janeiro (UFRJ—acronym in Portuguese) and its project Green Fund, located in Rio de Janeiro; Federal University of Lavras (UFLA—acronym in Portuguese), located

in Minas Gerais and Universidade do Vale do Rio dos Sinos (UNISINOS), located in Rio Grande do Sul.

2 Case Studies and Its Funding Models

Among the universities chosen, two of them, UFRJ and UFLA, are public education, while UNISINOS is a private university. Regarding their location, UFRJ is the only institution located in a Brazilian capital and hence near a large city; UFLA and UNISINOS are in small towns, their population does not reach one million inhabitants (IBGE 2010). The research methodology was based on reports published by universities as well as scientific papers and on universities web sites.

2.1 Brazilian Universities

2.1.1 UNISINOS

UNISINOS is the university with the oldest environmental management program, with two main campuses with around 30,000 students between undergraduate and graduate. UNISINOS is recognized as the first Latin American university to achieve ISO 14001 certification (Marco et al. 2010), with a makeover campus project into a green model, which has its beginning in 1997 through "Verde Campus" project. The university succeeded after two years of planning its first ISO 140001 certification in 2004, for the almost 1 km^2 of São Leopoldo campus (SGA-UNISINOS 2004). With annual performance reports, the environmental management system of the university, with over 10 years of existence, has projects in all major areas of sustainability (water and energy efficiency, water treatment and recycling), and external audits to campus operating processes (Relatório Anual-SGA UNISINOS 2014).

Despite counting on partners and on the injection of funds from public and private sources, the Environmental Management System funding process seem to come from the university's own resources, as shown by the Self-Assessment reports (2013, 2014) and the Annual Reports—SGA (2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013a, b, 2014). At this financing strategy, in which the university's resources are relocated to the area of environmental management, between 2005 and 2014 the amounts of water and energy consumption reduced even with the expansion of the university, from 163.610 to 77.076 m^3 and 13.710 to 11.071 MWh/year respectively (Relatórios Anuais—SGA 2005, 2014).

2.1.2 UFLA

UFLA, with just over 16,000 students and an area of 4.7 km^2, had started the process of building a sustainable campus in 2009. As HEI, which had its foundation based in an agronomy high school, the campus sustainability initiatives are mostly directed to agronomy, especially in the area related to treatment of chemical and

biological waste, as well as consciousness campaigns. Unfortunately, there are few papers about UFLA case, but it is possible to measure the success of actions taken by this HEI through the world sustainable ranking of universities, that is Green Metric. In this ranking, UFLA is pointed as the best Latin American university; UFLA is placed at top five best university among the rural universities and has been improving its position year after year (Green Metric 2012, 2013, 2014).

The entire development process of the actions at UFLA was financed by public resources from various federal institutions such as Ministry of Education (MEC—acronym in Portuguese), Department of Higher Education (SESU—acronym in Portuguese) and the Financier of Studies and Projects (FINEP—acronym in Portuguese), through public calls for tenders of these institutions. Between 2009 and 2011, it was more than R$ 23 million invested on project as exchange of distillers by reverse osmosis devices, which provide 80 times less power consumption and 20 times less water consumption. A sewage treatment plant was also built and provided not only the treatment of sewage as the creation of laboratories for different courses (Magriotis 2013).

2.1.3 UFRJ

UFRJ and its "Cidade Universitária" campus, located in an area of 5.2 km^2, with approximately 60,000 students, high energy and water consumption as well as its high circulation of people and vehicles may be compared to a medium-sized city. The "Fundo Verde de Desenvolvimento e Energia para a Cidade Universitária da Federal do Rio de Janeiro" project (Green Fund), focuses its actions on the sustainable development of the campus and has as its aim the transformation of the campus into a living laboratory of ideas for cities. An important feature of the project is its visibility outside the academic world. In spite of the project has just started in 2013, projects in favor of campus sustainability had large insertion in the media. Its financing way brings an innovative character even at an international level.

As a result of a partnership among the municipal energy concessionaire, federal and state government, and UFRJ, the fund comes from the exemption from state tax collected on the electricity bill of the university campus. This amount reverted to the fund of sustainable projects is approximately 0.2 % of state revenue that comes from this tax and it corresponds to nearly R$ 6 million/year for 10 years. With actions being implemented is expected that by the end of 2016 the various projects of the Green Fund provide savings of about R$ 500.000,00 a year in energy efficiency and generation projects and more than one million liters of water in processes reuse and efficient use of water.

2.2 Why Are They Successful?

The choice of the aforementioned universities took into account the success achieved by the HEI in transforming the campuses into sustainable models, beyond the fact that they have different ways of creating funds for sustainable management

of the campus among them. The criteria used to qualify as successful sustainable HEI took into account the number of barriers surpassed by these HEI during the implementation process of sustainable campuses and the amount of money invested in their projects.

The barriers were selected according to the previously study case presented in Brazilian and international paper. The main barriers pointed by authors are lack of interest of staff, administrators and students; lack of financial resources; the organizational structure and the predominant culture in the university; lack of knowledge on how to perform the actions; large payback time of investments; and lack of outside interest for the sustainable development of HEI (Dahle and Neumayer 2001; Magriotis 2013; Brandi et al. 2015).

The HEI selected overcome all the barrier presented in different levels. For example, meanwhile UNISINOS seems to have less external interest to invest in sustainable develop than UFRJ and UFLA; the interest of staff, administrators and students it is stronger in UNISINOS than UFRJ. However, a better understand of how each of the HEI chosen overcome the barrier would require an internal point of view. For this, a different methodology, like interviews with members of the HEI sustainable program, would be necessary.

The other issue regard the money invested by the HEI chosen. Considering the bibliographic review done, none other university in Brazil presented values close to the HEI mentioned and a different process to finance sustainable projects (Chart 1). Despite the methodology of assessment does not consider the social aspect of the sustainability, for the propose of the paper which is evaluate types of investment in HEI, the criteria fulfill this task.

3 The Financing Models and Its Replication Capacity

UNISINOS operation model of sustainable projects demonstrates that through institutional organization it is possible to implement sustainable actions, using the university's own resources. The replication of this type of funding at HEI in Brazil, both public and private, is enormous and it already has extensive technical and scientific material for support. Among the materials available are documents which

Chart 1 Money invested by the HEI

	Invested (USD)*	Span	References
UNISINOS	6,013,112.71**	2011–2014	UNISINOS self-Assessment reports (2013a, b, 2015)
UFLA	6,353,591.16	2009–2011	Magriotis (2013)
UFRJ (Green Fund)	2,991,173.52	2013–2015	Original data

*USD value 3,62 Reais. Value in 20/03/2016

**The value express the investments in infrastructure and environmental projects (including also research, develop and outreach)

are published by the Federal Government to establish good management practices and use of electricity and water to entities of federal public administration (Portaria 10 2015), that establish environmental sustainability criteria in the procurement of goods, services or works by the public administration (Instrução Normativa 01 2010), and examples of sustainable procurement available in the Ministry of Planning site (http://cpsustentaveis.planejamento.gov.br/licitacoes-sustentaveis Last accessed 13/01/2016).

As a private university, UNISINOS serves as an example since available in its website operating instructions to control waste generation, vendor management and maintenance of equipment, which are subject to external audit for compliance and certification verification. Documents as "Sustainable Procurement—the strength of public and corporate consumption for a green and inclusive economy" (Betiol et al. 2012) and the "Green Guide for Universities" (IARU 2014), also provide good practice for universities, which several of them can be financed through the reallocation of resources and adaptation of the buying process for their own HEI.

The financial barrier for investment on larger projects is one of the negative points of the model applied by UNISINOS, for instance the photovoltaic structures. Even with a continuous cost reduction of projects of this level through the years, its implementation is still quite expensive, mainly to Brazil, where most of the equipment is imported. In particular, public HEI, the development of this sustainable project finance model with resource reallocation for environmental management, can also face problems at administrative level. Due to closed budgets, impossibility of reallocation public money and perhaps the need to carry out training, the application of these methods may become unfeasible.

Project financing forms used by UFLA and UFRJ lighten the shortcoming presented by the model applied at UNISINOS. Since the projects for the sustainable development of campus have already begun capitalized with resources, then they enable implementation of both simple designs (changing light bulbs with more efficient models) and large ones (e.g. photovoltaic structures), allowing greater economy of natural and financial resources in a shorter period. As demonstrated by Vaz et al. (2010) most of the universities in Brazil already have, at some level, internal department for environmental management of the campus. These staff may be responsible for seeking funding opportunities through the assistance of teachers and researchers at IES, they would have a technical support for project constructions.

The project development requires great coordination between different sectors of the HEI, and out of them, for the formation of the fund and implementation of sustainable projects. This feature is well defended by experts and it is pointed as a crucial issue for the development of the project, as critical as the source of financing (Dahele and Neumayer 2001; Magriotis 2013; Brandi et al. 2015). In this regard, the Green Fund—UFRJ is highlighted and serves as good example with the articulation made between public and private sectors in building its financing fund. This model brings clear benefits to public agencies; as far as by refraining from raising part of an aliquot of a service tax, the money invested in sustainable actions

bring a further reduction of the amount paid by this service tax—e.g. for energy—plus reduction of the amount paid for other services such as water, purchase of inputs, and so on.

As a disadvantage point, as the projects are funded by public money, they are tied to political and economic status of the country or state. However, this point can be overcome using different national and international funding agencies, which increasingly is developing partnerships and creating space for financing sustainable projects (PBMC-GT3 2012). Another source can come through partnerships with companies and industries that see in HEIs an innovation area, a display window for new technologies and development (Perkmann and Salter 2012). All this movement is expanding through reports of the Intergovernmental Panel for Climate Change (IPCC) and their studies that emphasize the need to adapt consumption to a more sustainable model (ES-IPCC 2014). The Chart 2 below show advantages, disadvantages and challenges of each HEI described summarized.

Chart 2 Advantages, disadvantages and challenges to replicate the HEI financing models

	UNISINOS	UFLA	UFRJ
AVANTAGES	• More likely to allow a sustainable planning of medium and long terms • More likely to promote a deep change in the HEI culture (e.g. sustainable process)	• More likely to implement expensive project, like solar power energy, without the worry of payback time • Likely will not be necessary the engagement of all sector of the HEI	• More likely to implement expensive project, like solar power energy, without the worry of payback time • Likely to allow a sustainable planning of at least a medium-terms
DISAVANTEGE	• Likely will have difficult to invest in expensive project, as solar power energy, without external help	• More likely, there will be no public calls for tenders enough to a full process of sustainable develop for the entire HEI	• Less likely, external factors like a governmental economic change cause the suspended of the partnership and the interruption of the sustainable program
CHELLENGE TO REPLICATE	A high level of coordination and engagement of the multiple sectors of the HEI is needed to the successful of this model	Once the financed projects are operating. Will be need coordination and engagement of the HEI to do not let those project be punctual or even extinguish the HEI sustainable program	The finance model require a high level of coordination among internal and external partners

Promoting these initiatives would lead the universities not only to a direct saving of natural and financial resource, but also create an opportunity to the adoption of project financing practices which were already implemented at international HEI. The possibility of creating a fund for sustainable projects, arising from the financial savings achieved through ongoing sustainable initiatives is an example of an interesting initiative (Weisbord et al. 2011; Indvik et al. 2013). Indvik et al. (2013) describes that the HEI reserve an approximate percentage of 28 % of the amount saved by the implemented sustainable projects, the HEI will build a fund to finance an extensive environmental management system campus. The adoption of this practice would benefit the HEI that follow the similar UNISINOS model, facilitating resource savings for investment in larger projects.

The practice of voluntary donation of students is a fairly spread model in HEI and it has full adaption capability to the Brazilian reality. This model has as one of the advantages the largest engagement of the student body in a program construction for the transformation of the campus into a sustainable model (Krumbein et al. 2010; Morris et al. 2013). A pilot test was held at a university in the city of Rio de Janeiro, in order to assess the viability of implementing this type of fundraising for monthly donations. According to this test, in a sample of 38 undergraduate students approximately 70 % would make donations. Resulting in an overall average of R$ 6 per student and an approximate fund of R$ 90.000 per month. The percentage of non-donators was higher than the one found in similar studies at US HEI (Krumbein et al. 2010); however it is still a viable practice if the amount of the pilot project is maintained.

The lack of articles on sustainable campus and environmental management issue in HEI in Brazil—primarily case studies, opens a gap for discussion mainly at a time in which is being increasingly discussed the importance of local features in decision-making in order to build an environmental management program (Schmitt 2013). Nevertheless, the simple adoption of more efficient and sustainable practices would represent a significant advance in the search for a more sustainable campus at Brazilian HEIs (Marco et al. 2010) and these practices are able to be put into practice by some of the abovementioned models.

4 Conclusion

The funding models adopted by UNISINOS, UFLA and UFRJ demonstrated technical viability of being replicated by other universities in Brazil. Despite the negative aspects inherent to each of the funding models, ways to manage these negative features were presented and they involve even models to create funds for sustainable projects which were already tested at foreign HEI. Even though technically replicable models, the necessary administrative coordination for the implementation of these models in other universities in Brazil may be a great interference throughout the process. Hence, it is needed a widespread of the benefits

in transforming the campus into sustainable models in order to make HEI university community more interested on the subject and consequently more organized.

Other project funding models not addressed at HEI abroad should also be studied and assessed according to the Brazilian perspective. With the diversity of HEI found in Brazil this research area still has great opportunity to be even more developed.

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Authors Biography

Bruno Allevato is graduated in Biology (Environmental Science) and MSc in geochemistry both by Fluminense Federal University, and MBE degree in environmental management by UFRJ. Working in the executive secretary at Brazilian Panel of Climate Change since 2013 and since 2014 at UFRJ Green Fund for Energy and Develop of UFRJ University City campus, working with sustainable project implementation.

Professor Suzana Kahn Ribeiro is graduated in Mechanical Engineering, MSc in Energy Planning Program and DSC in Industrial Engineering form the Federal University of Rio de Janeiro (UFRJ). Nowadays she is professor at COPPE/UFRJ, is coordinator of the UFRJ Green Fund for Energy and Develop of UFRJ University City campus, "ad hoc" consultant for the Brazilian Research and Development Council, and President of Scientific Committee of Brazilian Panel on Climate Change. She was also Sub Secretary of Green Economy of Rio de Janeiro State Government form 2010–2013 and she worked at the Brazilian Federal Government as the National Secretary of Climate Change at the Ministry of Environment form 2008–2010. She has published several papers and theses in the area of energy, transport, environment and climate change.

Part II
Implementation of Sustainability in Practice

Improving Building Energy Performance in Universities: The Case Study of the University of Cambridge

Tim Forman, Roberta Mutschler, Peter Guthrie, Eleni Soulti, Bryn Pickering, Viktor Byström and Si Min Lee

Abstract

Reductions in energy demand by universities in the UK are increasingly called for due to both national carbon reduction policies and a specific target set out by the Higher Education Funding Council for England (HEFCE). The University of Cambridge has set its own targets to reduce carbon emissions and energy consumption, but behavioural, organisational and policy barriers are continually impeding the achievement of these targets. This paper focuses on three studies performed in various buildings at the University. The first study investigates the organisational and behavioural aspects of reducing energy demand. The second study explores the energy performance gap in new buildings and the significance of occupants' behaviour. The third study explores the potential and actual performance of renewable energy sources in the University Estate. These three different angles of exploration converge in similar findings that are interpreted as starting points to be addressed when improving the energy performance of buildings. It is argued that to reduce the environmental impact of the University, a number of recommendations should be considered in future energy reduction schemes. These are: the inclusion of sub-metering and unregulated loads; the need to set long term targets; improving communication flows between all stakeholders; improving staff training and information exchange; and developing closer understanding of occupants' behaviour and related impacts on energy consumption.

Keywords

Carbon reduction · Energy demand · Performance gap

T. Forman (✉) · R. Mutschler · P. Guthrie · E. Soulti · B. Pickering
V. Byström · S.M. Lee
Department of Engineering, Centre for Sustainable Development,
University of Cambridge, Trumpington Street, Cambridge CB2 1PZ, UK
e-mail: tim.forman@eng.cam.ac.uk

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1 Introduction

The UK has a national target to reduce carbon emissions by 80 % by 2050 compared to 1990 levels (UK Parliament 2008). In response, the Higher Education Funding Council for England (HEFCE) in 2009 set sector Scope 1 and Scope 2[1] emissions reduction targets of 34 % by 2020 and 80 % by 2050 against a 1990 baseline (HEFCE 2010).

The University of Cambridge (University) has established its Carbon Management Plan for 2010–2020 to respond to the HEFCE target and to national legislation. This seeks a 34 % reduction in Scope 1 and Scope 2 carbon emissions by 2020 against a 2005–06 baseline (University of Cambridge 2010). A number of policies and initiatives have been established to engage students and staff with this target.

The University has 330 operational buildings which accommodate around 19,000 students and 10,000 staff, and include a total gross internal floor area of approximately 640,000 m^2. Its estate includes buildings more than 800 years old with important conservation status, as well as a range of more recent and new constructions. The University's Estate Management office is responsible for the development, management and maintenance of the University's estate, and its Environmental and Energy Division manages strategic and operational initiatives aimed at reducing carbon emissions.

Despite efforts by the Environmental and Energy Section, a range of buildings, initiatives, and renewable energy installations are not delivering expected energy and emissions reductions. University Scope 1 and Scope 2 emissions totalled approximately 71,000 tCO_2e in 2005/2006, and increased to approximately 78,000 tCO_2e in 2008/2009 (8 % increase) and 85,000 tCO_2e in 2013/2014 (20 % increase on 2005/2006).

This paper presents three pieces of research that examine the University's emission reduction efforts. It examines factors of disparity between targeted and achieved energy reduction, and outlines recommendations for improving technological, operational, as well as organisational and behavioural strategies at the University. Many aspects of the findings will have relevance to other organisations.

[1]The World Resources Institute developed a classification of emission sources around three 'scopes': 'Scope 1' emissions are direct emissions that occur from sources owned or controlled by the organisation (e.g. Boilers, vehicles); 'Scope 2' accounts for emissions from the generation of purchased electricity consumed by the organisation; 'Scope 3' covers all other indirect emissions that are a consequence of the activities of the organisation, but occur from sources not owned or controlled by the organisation – for example, commuting and procurement. Scope 3 emissions are not included in HEFCE targets.

2 Literature Review

2.1 Performance Gaps in Non-domestic Buildings

UK Building Regulations stipulate minimum energy performance standards for new construction and substantive renovation, and address heating, cooling, ventilation and fixed lighting (termed 'regulated energy'). Although plug loads can comprise a significant proportion of total building demand, this aspect of energy demand is not controlled by Building Regulations.[2]

Both regulated and unregulated energy demand can vary significantly from design estimates and this performance gap has been well documented. Carbon Trust (2011) describes that among its case studies, 75 % of buildings did not attain expected performance reporting, with an average disparity of approximately 16 %—ranging as high as 500 % depending on design modelling. The Zero Carbon Hub (2010) reported similar research in which no case studies performed better than predicted, with actual consumption 10–120 % higher than design estimates. Similarly, the PROBE study found that most of 23 reviewed buildings consumed double estimated energy (Bordass et al. 2001). Finally, Menezes et al. (2012) analysed energy performance of office, school and university buildings and found measured energy use was 60–85 % higher than predicted use. Common factors of performance gaps are described in this section.

2.2 Factors of Performance Gaps

2.2.1 Influencing End-User Energy Behaviour

De Wilde (2014) argues that erroneous design assumptions about occupant behaviour are a primary factor in performance gaps. The focus of policymakers on technological approaches to meeting emissions targets—while logical—misses important reduction potential from behaviour change (Azar and Menassa 2012). Energy behaviour, however, varies widely between users and against physical infrastructure (Lopes et al. 2012) and often defies easy prediction or influence.

Literature suggests that initiatives for behavioural change are generally more successful when they harness social connectivity and empower 'bottom-up' change (Feola and Nunes 2013). Research also points to important innovation potential rooted in social and organisational settings (Smith and Seyfang 2007). Grabs et al. (2015) show that successful groups are often correlated with institutional flexibility and with goal-setting, which foster motivation and empowerment. Reflecting this, the Gurdon Institute of the University developed an inter-laboratory energy

[2]Plug loads include task lighting, lifts and escalators, catering equipment, non-centrally controlled heating, computer and laboratory equipment, among other demands. The proportion of energy demand represented by these 'unregulated' loads varies widely with building construction and use, but commonly exceeds one half total demand. Unregulated energy loads are generally electrical in nature.

campaign which combined competition, incentives (e.g. prizes, cake), information (induction, meetings, displays) and reward of individual commitment and achievement. The campaign delivered a 19 % reduction in energy demand from workplace zones over six months (Wellcome Trust and Cancer Research UK 2012).

Other authors highlight the importance of infrastructure, resources, investment of time, and long-term initiatives as factors in successful behavioural awareness and change initiatives (Feola and Nunes 2013; Buchs et al. 2012; Heiskanen et al. 2010).

Many espouse that to address sustainability in universities, a 'learning for sustainability' approach should be embedded across all aspects of institutional operation (Ralph and Stubbs 2014). Anand et al. (2015) developed a sustainable education initiative for schools and universities in Quebec, Canada, and evaluated its impacts on the institution members. They concluded that the integration of sustainability ethos into higher education requires a profound cultural change more than a technical shift, and should be reinforced by alignment of teaching, research and institutional management activities. Kastner and Matthies (2014) point to university staff as role models with important influence on students and argue that this, and staff members' roles in decision-making, suggest that initiatives should prioritise inclusion of staff.

2.2.2 Design Stage Errors and Inaccuracy

Human error in design calculation can cause significant misestimating of actual energy demand. Numerous studies have shown failures to accurately assess high-demand equipment, inefficient devices, or occupancy (Carbon Trust 2011).

Unregulated loads are fundamental uncertainties in buildings and, combined with other complexities, make accurate design stage energy modelling and simulation difficult (Ahmad and Culp 2006; de Wilde 2014; Menezes et al. 2012). Forecasting energy demand is further complicated by design or construction stage 'slippage' (Bordass et al. 2004).

2.2.3 Construction, Operation and Maintenance

Literature is clear that when buildings are not constructed, operated or maintained as anticipated, large disparity from design energy demand can ensue (Bordass et al. 2001, 2004; Demanuele et al. 2010). Furthermore, although facility managers (FMs) have direct control over significant building energy through centralised building management systems (BMS), this control is limited by inadequate training, resources, overly complex BMS controls, or disempowerment of FMs (Goulden and Spence 2015; De Wilde 2014).

2.2.4 Commissioning and Post-occupancy Evaluation

In practice, most designers and contractors invest little in assessing how their buildings actually perform in use; this reflects reticence of many clients to pay for such assessment. Better cooperation between designers, contractors and end-users to optimise economic and environmental performance of buildings has long been promoted as a key path to reducing performance gaps (Way and Bordass 2005).

Post-occupancy evaluation (POE), as well as handover and commissioning protocols such as Soft Landings, outline effective processes for optimising new and refurbished buildings (BSRIA 2011) and are slowly gaining ground in common practice. Such protocols maintain the investment of designers and constructors in building performance and ensure that operation is aligned with design intent.

3 Background Information

3.1 Planning Policy

In 2003, the London Borough of Merton was the first local authority to address UK national renewable generation targets in local planning policy. Merton required that at least 10 % of site energy demand in new commercial buildings larger than 1000 m^2 was met through renewable sources. This policy became known as the 'Merton Rule' and was adopted by many local authorities in the UK, including Cambridge City Council in 2006.[3] Renewable installations included in this research were specified in line with the Merton Rule.

3.2 University of Cambridge Initiatives and Programmes

The University has supported a variety of endeavours aimed at reducing emissions from its complex estate. Literature typically classifies such initiatives in three categories: technological, organisational/managerial and behavioural (Ruparathna et al. 2016).

Among the technological initiatives, the University launched the Energy and Carbon Reduction Project (ECRP) in 2011 to target the five most energy-intensive departments in the University. With a 10-year £2M budget, the ECRP funds implementation of experimental and previously untested strategies which pose no adverse impact on the University's research activity.

The Electricity Incentivisation Scheme (EIS) was established in 2008 and is the sole organisational initiative at the University. It encourages individual departments to take responsibility for their electricity use by allocating annual consumption targets and incentivising achievement of targets through financial reward or penalty (University of Cambridge 2013).

The University has implemented several initiatives to encourage energy conservation behaviour. These include the Energy and Environment Coordinators Network, which in parallel with the EIS assigns responsibility to a single person per department for raising awareness and promoting behavioural changes. The Green

[3]The merit of the Merton Rule has been debated heavily in recent years, and Government focus on localism in planning controls has led to changes in many legally binding local policies on renewables.

Impact Scheme (part of a National Union of Students initiative) promotes the formation of working groups to target energy savings within departments. The Switch Off Week campaign encourages switching off lights and appliances when not in use. The NetPositive and Living Laboratory for Sustainability initiatives provide students with opportunities to improve sustainability on the University estate through projects and research.

4 Research Overview and Methods

The organisation of this section reflects the three distinct research projects presented in this paper.

4.1 Research Project 1: Energy Consumption, Performance Gap and POE

Project 1 studies the energy performance gap in Sainsbury Laboratory, a building with an ambitious design that has been recognised by several prestigious awards. The Project analyses energy consumption by end-use (including unregulated loads) and interprets POE results.

The Laboratory was constructed in 2010 to house the Plant Science Research Centre. It received a BREEAM Excellent rating in design and post-construction stages and obtained an Energy Performance Certificate (EPC) rating of B (Mara 2011). The laboratory consists of two separate buildings with a total gross floor area of 11,687 m^2. Building A contains offices, laboratories, meeting rooms, a lecture theatre and a café. Building B contains plant growth chambers (PGCs) and one office. Heating is provided through a low temperature hot water heating system; cooling is provided through fan coil units, chilled beams, and closed control units in equipment areas. Cellular offices have limited individual heating and cooling controls, while the rest of the areas are controlled by the BMS.

Energy consumption is assessed through the BMS, which recorded monthly sub-meter readings between 2011 and 2013. Additionally, in order to identify and understand the impacts of occupant behaviour on the building energy performance as well as the influence of building controls on thermal comfort and productivity, a web-based occupant survey (developed at the University of Berkeley[4]) was conducted in February 2014. The survey collected 25 responses, equivalent to one-third of the building occupants (Fig. 1).

[4]Survey based on the Occupant Indoor Environmental Quality survey conducted by the Centre for the Building Environment a the University of California Berkeley (2010).

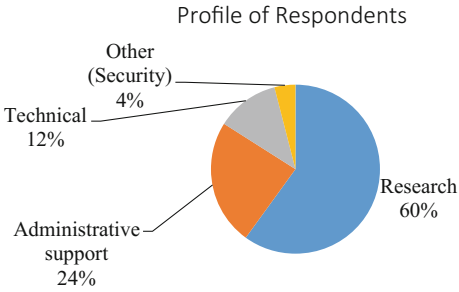

Fig. 1 Profile of the 25 Sainsbury Laboratory survey responses received by email

4.2 Research Project 2: Organisational and Behavioural Factors

Project 2 examines organisational and behavioural factors in the EIS initiative. Robinson College is used as a case study to examine energy behaviour and consumption awareness of students and staff. The impacts of policies and schemes are assessed within University departments.

A questionnaire was distributed via email to 569 students, 105 staff members and 80 fellows at Robinson College. A total of 150 responses were received (20 % of the potential survey population).

Ten departments were selected for interview research based on their 2012/2013 electricity consumption either being highest among University departments, or having significant deviation from allocated targets (Table 1). Semi-structured interviews with FMs were conducted across the included departments. FMs hold primary responsibility in the EIS and the interviews evaluate their awareness of the initiative and their emergent strategies for energy reduction.

Interviews were based on the following questions:

- What is the department's understanding of the EIS?
- Have there been any energy saving measures implemented in the department?
- What would be the ideal way for the department to work with energy saving measures more generally?

4.3 Research Project 3: Renewable Generation Analysis

Project 3 analyses renewable generation performance against the Merton Rule. Analysis includes calculation of PV and wind turbine potential and comparison to actual achievement. PV potential is assessed based on total available roof area, flatness and absence of shading (listed buildings and pitched roofs were excluded) and is based on information from Estate Management and use of Google Maps to visually inspect rooftops. Power density of existing PV installations is calculated with the Photovoltaic Geographical Information System.

Table 1 Target and actual energy consumption in 2012/2013 of the ten departments included in Research Project 3

Department	Target (MWh)	Actual (MWh)	Difference (%)	Reward/fine (£)
Chemistry	10,922	10,693	2.1	22,591
Computer laboratory	1759	1398	20.5	35,486
Pharmacology	946	747	21.0	19,548
Music	407	365	10.2	4091
Pathology	2742	2963	−8.1	−21,771
Experimental psychology	1676	1930	−15.1	−24,919
DAMTP	1317	1480	−12.3	−15,997
Clinical biochemistry	386	432	−11.9	−4529

NB A negative integer in the 'reward/fine' column denotes a fine levied due to failure to meet reduction target

Wind power potential is assessed against site criteria (e.g. noise and visual impact), and six potential sites are identified. Assessment includes a range of turbine sizes and wind speed datasets, assumed wake losses, topple distance and water course. Assessment is based on relevant literature (Gasch and Twele 2011), studies by the University's Partnership for Renewables (PFR), technical information from Renewable Energy Systems Limited, and Cambridge City Council local plan (Table 2).

Finally, based on site inspection and three case studies, operation, maintenance and monitoring practices in Estate Management are assessed.

5 Results

5.1 Research Project 1: Energy Consumption, Performance Gap and POE

The study of Sainsbury Laboratory found significant disparity between design estimate and actual energy use. In 2011/12 and 2012/13 the actual electricity consumption of the laboratory was 59 and 46 % less than estimated figures in the building logbook. In contrast, the actual gas consumption was 298 and 308 % higher than estimated (Fig. 2).

Analysis revealed that the electricity discrepancy was mainly due to an overestimation of the PGC consumption in Building B. Design engineers anticipated PGC consumption to be 5,493,907 kWh/year; yet consumption in 2012/13 was only 1,200,000 kWh (78 % lower). Although, design calculations assumed 100 % building occupation and occupation in 2012/13 was only 75 %, this does not explain the significant disparity between estimated and actual consumption.

In laboratory areas, underestimation of gas can be explained by excessive unregulated loads (explained in Sect. 2). Gas required for laboratory experiments

Table 2 Prescribed separation distances for different factors used to assess the maximum number of wind turbines a particular site could hold

Criterion	PFR	Industry	Literature	Regulatory
Visual and noise	450 m	600 m	300–600 m	2000 m
Wake losses	6D	8D	6D	–
Wake losses (cross)	4D	2D	4D	–
Topple distance	H + 0.5D	H + 0.5D	H + 0.5D	–
Water course	30 m	–	–	–

D refers to the rotor diameter and *H* is the hub height of the turbine

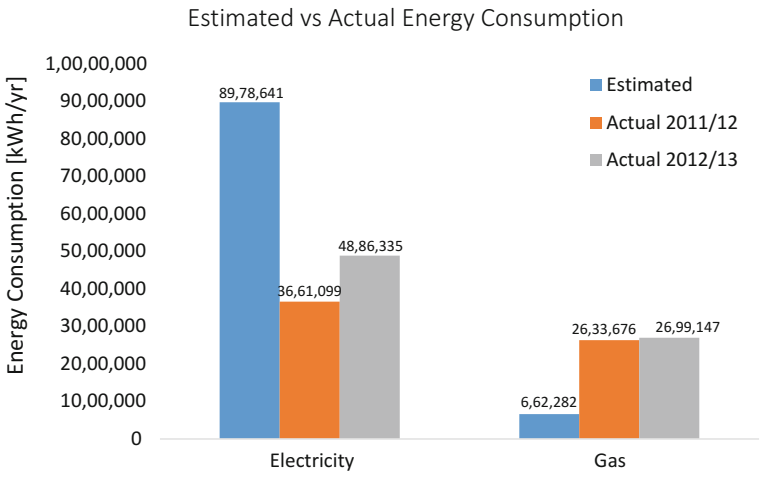

Fig. 2 Estimated energy consumption according to Sainsbury Laboratory Logbook compared to the energy consumed from August 2011 to July 2012 and from August 2012 to July 2013

was not included in design estimates. In 2012/13, total gas consumption in the Sainsbury Laboratory was four times higher than design estimated regulated gas consumption.

In February 2014, end-use consumption of gas was recorded daily for three weeks. Results showed that 94 % of gas in this month was consumed by heating boilers. Figure 3 shows that gas consumption in 2011/12 was poorly correlated with weather, however data for 2012/13 show strong correlation. The inconsistency in 2011/12 is explained due to lower occupancy (25 % occupancy in 2011) and activity level.

The February 2014 study also showed high average temperatures in two rooms; with one office ranging from 21 to 23 °C (due to comparatively higher thermal insulation) and another ranging from 22 to 28 °C (due to a faulty thermostatic valve).

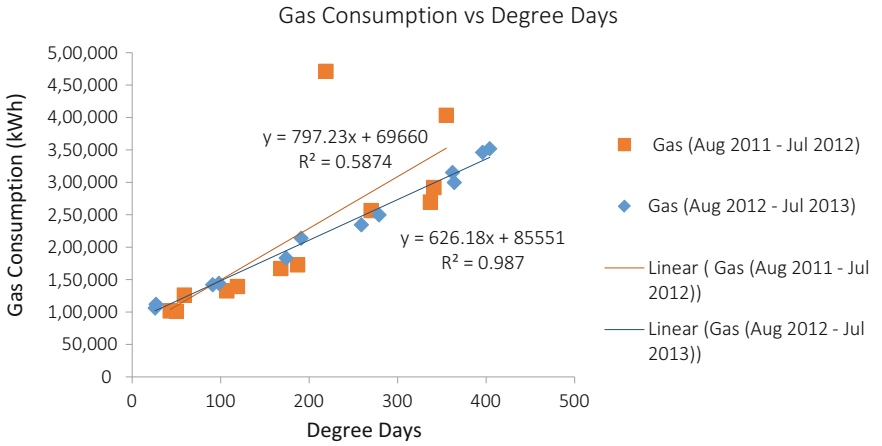

Fig. 3 Sainsbury Laboratory gas consumption against heating degree days for year 2011/12 and 2012/13 with base temperature of 15.5 °C taken from Carbon Trust (2012)

5.2 Occupant Survey Results

5.2.1 Personal Control

The majority of survey respondents indicated that they perceived having no control over heating (76 %), cooling (84 %) or ventilation (92 %). However, a minority indicated a perceived absence of lighting control (36 %).

5.2.2 Thermal Comfort

In contrast to the generally high temperatures observed during monitoring, 13 occupants responded they felt cold and eight responded that they felt neutral (n = 25). Only 28 % of the respondents reported that they never felt cold, while those who felt cold faced problems at different times of day. Low heating was the mode response for explanatory factors, with wide variation in responses (Fig. 4).

Despite dissatisfaction with temperatures, 56 % of the occupants said they took no remedial action. The most common explanations selected were lack of awareness of appropriate responses and lack of control (Fig. 5).

5.2.3 Lighting

Building occupants were generally more satisfied with lighting, compared to other environmental conditions (only 12 % indicated dissatisfaction). Regarding visual comfort, the percentages of dissatisfied, neutral and satisfied respondents were 20, 44 and 36 % respectively.

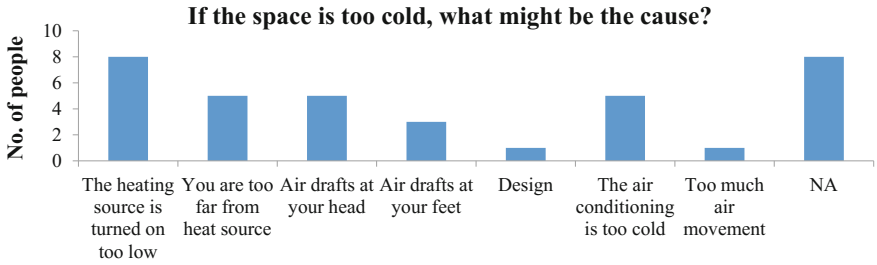

Fig. 4 Possible causes of cold sensation felt by the occupants indicated in Sainsbury Laboratory POE

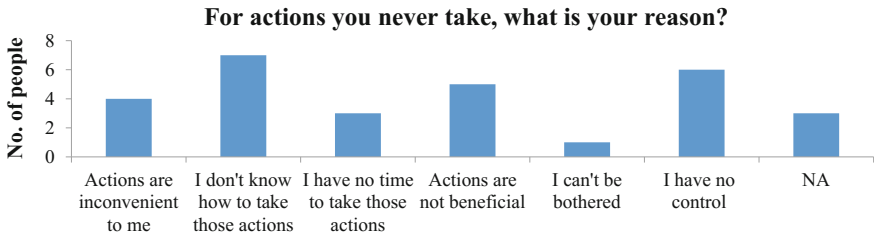

Fig. 5 Responses to the question "what is your reason for actions you never take?" in Sainsbury Laboratory POE

5.2.4 Building Controls

Satisfaction with lighting controls was indicated by 48 % of respondents, while 44 % indicated having no access to controls in workspaces. Dissatisfaction with environmental controls was most common with exterior shading (36 %), thermostats (32 %) and interior shading (28 %).

5.2.5 Energy Usage

The majority of respondents reported following energy saving behaviours, such as turning off computers at night (78 %), switching off electrical equipment when not in use (64 %), using added clothing to stay warm (64 %), switching off lights before leaving rooms vacant (60 %) and drinking something hot/cold (44 %) (Fig. 6).

Respondents were asked to identify explanations for any lack of energy-saving behaviour. The most common explanations selected were not being aware of appropriate actions (28 %) and having no control (24 %). Largely disregarded responses were lack of time, inconvenience, or believing that actions were not beneficial.

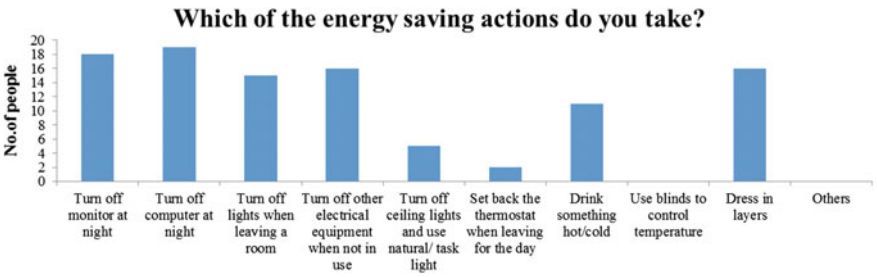

Fig. 6 Responses to the question "Which of the energy savings actions do you take?" in Sainsbury Laboratory POE

6 Research Project 2: Organisational and Behavioural Factors

6.1 Robinson College Questionnaire

Only 35 % of respondents were unaware of renewables installations on a University scale and 37 % on a College scale (Fig. 7). This implies a lack of visibility or publicity of the University and College's renewable sources.

Figure 8 shows responses to questions about awareness on energy use, which indicate that students are the least aware of their energy consumption although they comprise the largest proportion of College members and are the only group to live on site. Generally, a greater number of respondents try to reduce energy waste than not, and fellows tend to be more conscientious about consumption. When asked about preferred format in which to receive energy consumption information, 26 % preferred real-time output on the College website, followed by 21 % monthly and 15 % daily output display. Another 15 % choose display on porter's lodge, while the least preferred formats were email and smartphones applications.

6.2 Departments Interview Results

Because interviews were semi-structured in nature, no quantitative analysis of results was conducted. Responses indicated that all departments were interested in reducing electricity consumption, yet preferred strategies varied significantly and the majority identified a lack of funding as the primary barrier.

6.2.1 Ownership and Responsibility

A lack of clarity about the role of the EIS programme 'leader' was identified as a central concern. Responses indicated a perceived distance between those bearing the cost of energy efficiency improvements, decision-makers, end-users and those having authority to implement changes.

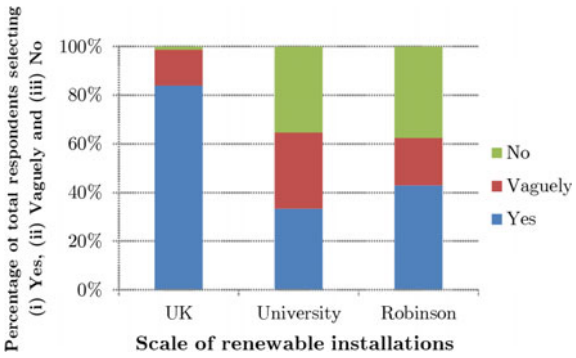

Fig. 7 Percentage of respondents that are aware, vaguely aware or unaware of renewable sources in the UK, University of Cambridge and Robinson College

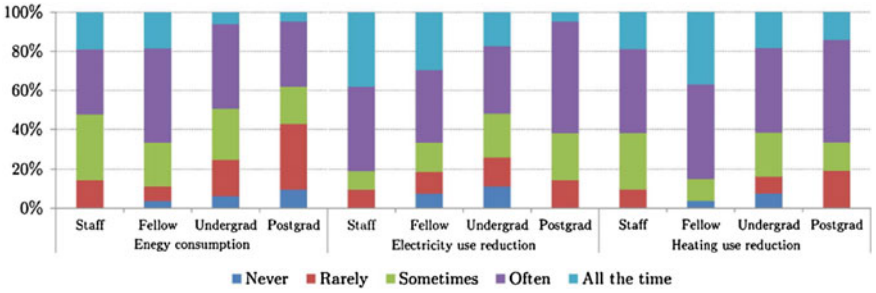

Fig. 8 Questions posed: (i) I am aware of my energy consumption in the College; (ii) I actively try to reduce electricity waste in the College; (iii) I actively try to reduce heat waste in the College. Responses are split between main respondent groups

6.2.2 Strategy

Many interviewees indicated a perception that their departments did not have a coherent strategy for long-term reduction of electricity consumption and that reduction was predominantly driven by short-term targets. This appeared rooted in the structure and management of the EIS initiative in which neither annual targets nor planned shifts in targets for future years were communicated to departments. Respondents indicated that without information on future trends, it was difficult to evaluate economic feasibility of measures. Moreover, financial reward to departments for meeting targets was not earmarked for specific purposes; several respondents expressed a desire for reward to support further reduction measures.

6.2.3 Monitoring and Recording

The inability of departments to understand the impact of measures and consumption factors was a recurrent theme in survey responses. This appeared rooted in the absence of sub-metering and monitoring. Independent of performance in EIS,

documentation and analysis of reduction achievements by departments was generally limited. Several departments highlighted a limited ability to differentiate between the effect of changes in occupancy and energy-saving measures. In other departments, shared metering impeded traceability.

6.2.4 Information Exchange

Interviews highlighted a need for increased exchange of information between departments to avoid redundant efforts. Research suggested that the mailing list relied on as the dominant form of communication was underused; one respondent suggested creating a bespoke website which would serve as a repository for information about efficiency and the EIS project.

7 Research Project 3: Renewable Generation Analysis

7.1 Renewable Generation Potential

Employing the methodology described in Sect. 4, 27 buildings were identified as suitable for PV installation; providing a total available roof area of 13,000 m^2 (2.4 % of total Estate roof area, with 10 % uncertainty factor). Table 3 presents estimates of average annual electricity production potential per PV area (W/m^2), drawn from different databases and data from the University Estate.

Analysis shows that against a relatively optimistic reference value (MacKay 2008), PV generation potential across the Estate equals just 2.1 % of the University's electricity consumption (109,942 MWh in 2008/09).

Using the wind power criteria described in Sect. 4, three potential sites were identified. These were capable of accommodating two turbines of 3 MW or four turbines of 900 kW. The significance of criteria used for this assessment should be highlighted; using alternate criteria (e.g. for visual and noise disruption) completely rules out the possibility of meaningful wind generation.

Figure 9 shows a summary of assessed renewable electricity potential for PV and wind turbines. Against 2008/09 consumption figures (above), it is evident that with the most optimistic assumptions, the University could produce just 16 % (17,200 MWh) from renewable sources. If planning permission of wind turbines were denied, this would fall to just 2.3 % (2500 MWh). Life cycle carbon values for PV, onshore wind and UK grid carbon intensity were taken from literature.[5] Using these values, calculating emissions reduction potential under optimistic

[5]Life cycle carbon value given by Edenhofer et al. (2012) for PV is 46 kg CO_2eq/MWh and for onshore wind is 12 kg CO_2eq/MWh. Values for UK grid carbon intensity given by DEFRA, 2013 are 491 kg CO_2eq/MWh in 2011.

Table 3 Average annual electricity yield in W/m^2 for the different methods

Method	Data source		Electricity yield (W/m^2)
Irradiation database	Climate-SAF (Joint Research Centre European Commission n.d.)	Horizontal	12.2
		Optimal	14.5
	Classic (Joint Research Centre European Commission n.d.)	Horizontal	11.1
		Optimal	12.8
University estate data	Department of Engineering		9.0
	Sainsbury Laboratory		12.4
Reference value	Taken from MacKay (2008)		20.0

The Climate-SAF database is based on satellite measurements while the classic database relies on ground measurements

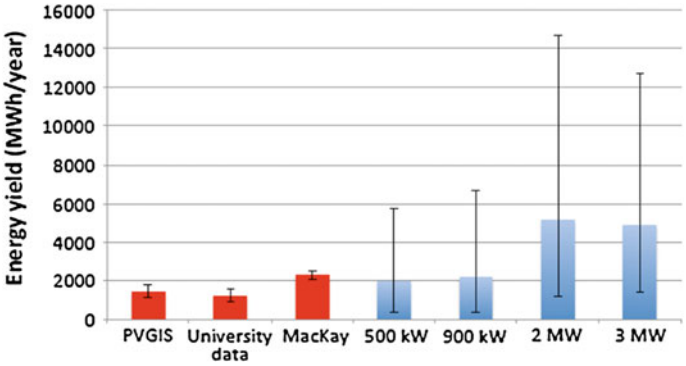

Fig. 9 Summary of estimated renewable energy output. *NB* The *red columns* show the output from installing solar PV panels on all possible university estate roofs, estimated using three sources of data. The *blue columns* show the output from four different sizes of wind turbines as estimated by using two sets of site selection criteria (PFR and Industry) and three sources for site wind speed. *Error bars* show the highest and lowest estimates

estimates (Table 3) indicated that 1100 and 7100 tCO_2 could be saved through PV and wind respectively.[6] The University's 34 % reduction target requires a reduction of 36,000 tCO_2 on 2005 levels, which is significantly higher than the combined 8200 tCO_2 under this optimistic scenario.

[6]If instead of using the most optimistic estimates, mid-range estimates were used, this figure drops to 5800 t of CO_2 (5200 tCO_2 from wind and 600 tCO_2 from solar PV).

7.2 Disparity Between Predicted and Actual Building Emissions

The comparison of predicted regulated and unregulated emissions in three buildings used for renewable specification shown in Fig. 10. Figure 11 shows significant disparity between the University Library and Sainsbury Laboratory. This highlights a shortcoming of the Merton Rule, which addresses regulated energy only.

Initial design prediction of regulated emissions from the Library extension was 20.02 kg CO_2/m^2. After model refinement and design improvements to comply with Building Regulations (Part L), this was reduced to 6.9 kg CO_2/m^2. Extrapolation of available post-completion gas and electricity consumption data to one year showed that predicted emissions were five times lower than actual emissions

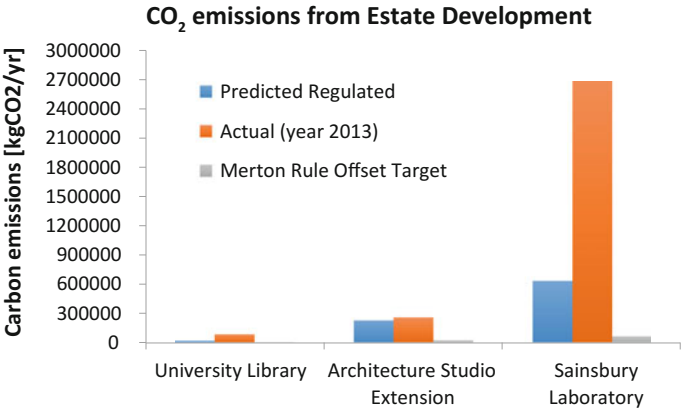

Fig. 10 Predicted and actual CO_2 emissions from estate developments requiring a Merton rule offset. Actual emissions reflect regulated and unregulated loads

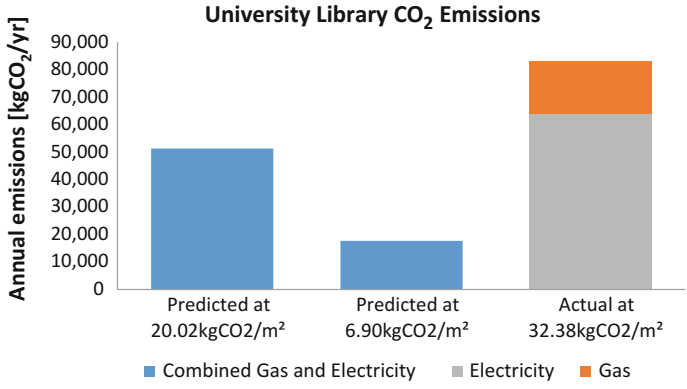

Fig. 11 Actual and predicted annual CO_2 emissions from the University Library

(interpreted to be partly due to unaccounted unregulated load) (Fig. 10). Hence, assumed offset from PVs equalled 2 %.

The 1040 m^2 rooftop PV array installed at the Sainsbury Laboratory in 2010 was specified against the Merton Rule. Again this building was found to meet only 2 % of actual building consumption. The array was determined to be delivering a significantly lower specific yield than other installations, which prompted a physical inspection. Examination found that insulation faults in two of seven inverters were causing current leakage to ground. The same study also noted that three of the five Ground Source Heat Pumps (GSHP) installed in different buildings of the University were signalling an undetected fault (in one for over a year), without remediation or even awareness of Estate Management. This highlights the critical importance of regular inspections, maintenance and well-trained Estates personnel.

8 Discussion

Literature underscores the importance to efficient building operation of what we term 'first principles': careful design stage analysis; robust commissioning and POE; and optimised operation and maintenance. It also argues that effective energy reduction initiatives rely on collective buy-in (i.e. goal sharing), empowerment of end-users to implement changes, and harnessing the power of social norms; this we refer to as 'best practice in initiatives'. Findings show the relevance of these factors across University settings.

Emerging from analysis is a cautionary note: if 'first principles' and 'best practice in initiatives' are not well aligned, a range of 'gaps' will likely follow. We outline here the divergences between targets (or intentions) and realities revealed in this project.

8.1 Physical Performance

A gap is observed between performance targets established by policy (i.e. Merton Rule and University targets) and actual site demand. This relates to failure to observe 'first principles', but also to other key factors. These factors may become entrenched in practice if disparity between predicted and actual emissions is not addressed by successive iterations of national and local policy.

The omission of unregulated energy in site energy estimates makes it difficult to target this significant source of emissions. It is important that in design stage, operation, and in reduction initiatives, unregulated energy can be assessed with reasonable confidence. Sub-metering can enable more meaningful assessment here.

Site energy use must be carefully monitored with appropriate granularity (from sub-metering and intervallic assessment) and should be aligned to allow useful

comparisons between buildings, users and load patterns. To improve future practice, operational staff, designers and constructors need to be informed by failure to obtain expected energy performance. The critical importance of POE and Soft Landings here cannot be overstated. Better commissioning would have, for instance, addressed underperformance, malfunctions and long delays in error recognition and repairs in GSHPs, remediation of PV inverter cabling leaking current to ground (Project 3), and occupants not understanding how to control indoor conditions (Project 1). Finally, monitoring can bolster energy/emissions initiatives by increasing end-user awareness of achievements and by ensuring traceability.

8.2 End-User Energy Behaviour

Disparity between design intentions and reality exists not just in energy consumption, but also in how occupant behaviour. Results highlight significant non-technological barriers to shifting energy behaviours (e.g. limited awareness of strategy, 'how to' knowledge).

This research also suggests that common—unfortunately predictable—technological barriers (e.g. inadequate environmental controls, limited knowledge of controls) are impeding progress on the University estate. There was considerable occupant dissatisfaction with environmental conditions and associated controls, even in the newly constructed Sainsbury Laboratory (Project 1). This is useful feedback for designers, who should consider the need to provide comfortable environments, while also enabling greater control and ensuring that users understand how to use controls.

To become enduring change, shifts in energy behaviour in universities must become embedded in university culture. Like Kastner and Matthies (2014), we argue that staff have a key role to play here. As role models and as key decision-makers, they are well-placed to concretise shifts toward more efficient behaviours. Therefore, initiatives and their parallel dissemination and knowledge exchange activities should harness the potential value of staff as agents of change.

Energy/emission initiatives should seek to align end-users, those stakeholders who bear the cost of efficiency measures, and those who develop targets and initiatives. Initiatives should do this while outlining and communicating long-term targets and making visible any achievement against these targets.

8.3 Maintenance and Operational Management

We widen the scope of meaning attached to 'energy behaviour' to include not only end-users, but also operational staff, who have direct control over significant energy demand and are well-positioned to influence unregulated energy. Achieving design performance relies on proper operation, maintenance, monitoring and optimisation.

This research highlights that FMs faced constraints such as limited time and skills, as well as role isolation (Project 2). This impeded robust understanding of energy demand and supply and in turn endangered a variety of failings, including poor maintenance and unrecognised equipment faults.

Shifts in operational behaviour can be encouraged through training, robust systems that provide detailed performance data and instructional information, sharing of best practices, and more sophisticated systems of operation and management.

8.4 Limitations

This paper has not intended to present a comprehensive overview of barriers to reducing emissions at the University; this would require significant further research. There are clear limitations to generalizability of the reported results to other University settings due to limited sample sizes. The qualitative research reported here—both in its inherent potential for subjective interpretation by participants but also with respect to limited response rates—should be understood as contributing indicative but not conclusive evidence. Similarly, quantitative methods have relied on meter readings, monitoring, literature review and calculations, and so have corresponding vulnerability to instrument error and compounded environmental and site complexities.

9 Conclusion

This paper has examined three pieces of research conducted at the University of Cambridge which have addressed distinct factors in efforts to improve energy efficiency and reduce emissions from the Estate.

Analysis provides insight into the complexities of achieving energy targets and outlines important lessons for future energy and emissions programmes at the University, as well as other universities and large institutions with similar motivations.

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Authors Biography

Tim Forman is a Research Associate at the Centre for Sustainable Development in the Department of Engineering at the University of Cambridge. His cross-disciplinary research addresses the technical and socio-technical challenges to designing, constructing and maintaining resilient and sustainable built environments. He is currently developing new approaches to testing and monitoring insulation retrofits in order to improve understanding of the impact of workmanship on retrofit performance. His doctoral work at Cardiff University examined performance gaps and unintended consequences in insulation retrofit of solid masonry walls. He holds an MSc in 'Theory and Practice of Sustainable Design' from Cardiff University and has worked in construction on a wide range of green and conventional projects. He teaches a variety of undergraduate and postgraduate topics including energy in buildings, sustainability theory and design, energy retrofit, advanced building management, and social research.

Roberta Mutschler is a Research Assistant at the Centre for Sustainable Development. Her research focuses on unintended consequences in insulation retrofitting of solid walls in buildings. Originally from Chile, Roberta graduated in Industrial Civil Engineering from Diego Portales University in 2011. After her graduation she worked two years, first in a mining project as Project

Engineer at MOSAQ Consultants, and later as Commercial Assistant Manager at Induelectro, a company of electrical solutions. After the experience in industry, she moved to England to continue with her studies. In 2014, Roberta completed a Master of Science in Sustainable Energy Engineering at the University of Nottingham. In April 2015, Roberta Joined the University of Cambridge, which is now her current job.

Peter Guthrie is Professor of Engineering for Sustainable Development at the University of Cambridge. A civil engineer, Peter worked in consultancy on infrastructure projects before coming to Cambridge in 2000, and has worked extensively in Africa and Asia. His research is focused on energy efficiency, urban development, resilience, and sustainable development in infrastructure projects internationally. Peter was founder, in 1980, and is now a Vice-President of RedR Engineers for Disaster Relief. He was a Non Executive Director of Buro Happold from 2010 to 2015. He was a member of the UK Department of Environment Food and Rural Affairs (Defra) Science Advisory Council from 2004 to 2011. He has served on the UK Government's Project Board for the Severn Tidal Power Study, and the Lead Expert Group on Disasters for the Government Office of Science. He was a member of the Global Agenda Council on Catastrophic Risks in the World Economic Forum 2011–2014.

Eleni Soulti has a background in architectural engineering and a master's degree in environmental design and engineering. Her first years of work experience were in architecture and sustainability consultancy, with a focus on environmental building certifications. In the past Eleni worked at the Centre for Sustainable Development at the University of Cambridge, conducting research in energy efficient technologies as well as the evaluation of embodied energy and carbon for building construction. Eleni is currently a Senior Technical Consultant at BRE, leading the commercial sector of the BREEAM UK New Construction technical team.

Bryn Pickering is a PhD candidate in the EPSRC Centre for Doctoral Training in Future Infrastructure and Built Environment (FIBE-CDT). Holding an MRes from the FIBE-CDT and an MEng in Energy, Sustainability and the Environment from the University of Cambridge, Bryn's primary research interest is in the supply of energy, particularly from renewable resources. His current research focuses on distributed energy resource optimisation in rapidly developing cities, applying a greater scope of uncertainty analysis to current energy modelling. Previous work has included a study of renewable energy resources at the University of Cambridge and mapping power outages in the Indian city of Bangalore.

Viktor Byström completed his MEng degree at Magdalene College, University of Cambridge, in 2014. While at Cambridge, he undertook research work to study the potential for renewables within the University Estate as well as the possibility to reduce university greenhouse gas emissions from cutting energy demand, all under the supervision of Professor Peter Guthrie. What interested him most at the time was how valuable information is or is not transmitted through large organisations and how behavioural science can aid the design of energy saving campaigns. Since he graduated, he has moved on to study the clarinet at the Ingesund College of Music in Arvika, Sweden, and he hopes to be an orchestral/chamber musician in the future.

Si Min Lee graduated from Cambridge University in 2014 with a degree in Mechanical Engineering and Masters in Energy and Environment. She is currently working in the Building and Construction Authority in Singapore. As an Executive Manager in the Green Building Policy Department, she plays a pivotal role in formulating the climate change mitigation policies for Singapore.

The Sustainability Journey of USM: Solution Oriented Campus Ecosphere for Vitalising Higher Education Action on GAP

Omar Osman, Kamarulazizi Ibrahim, Kanayathu Koshy, Noor Adelyna Mohammed Akib and Ahmad Firdaus Ahmad Shabudin

Abstract

Grappling with the challenges of sustainable development will require a total change in the way we interact with the ecosystems that support our lives and the people we live with. This means that all individuals and societies must be equipped with knowledge, skills, perspectives, values and issues that enable them to drive such changes. Consequently, universities across the world have been trying to integrate Education for Sustainable Development (ESD) into their curriculum. This global ESD commitment gained further strength when the UNESCO World Conference on ESD launched the Global Action Programme (GAP) on ESD in 2015 with five priority areas. The sustainability journey of Universiti Sains Malaysia (USM) has a lot in common with the experience of UNESCO globally and GAP in particular, in that the University too is convinced, with its long-term involvement in ESD, that a *whole-institution* (*GAP Priority* 2) commitment which involves *policies* (*GAP Priority* 1) and practices which factor the creativity of *educators* (*GAP Priority* 3), and the youthful vigour of *students* (*GAP Priority* 4) are integral to promoting relevant changes

O. Osman (✉)
Universiti Sains Malaysia, Penang, Malaysia
e-mail: omar_o@usm.my

K. Ibrahim · K. Koshy · N.A.M. Akib · A.F.A. Shabudin
Centre for Global Sustainability Studies, Universiti Sains Malaysia, Penang, Malaysia
e-mail: kamarul@usm.my

K. Koshy
e-mail: kanayathu.koshy@gmail.com

N.A.M. Akib
e-mail: adelyna@usm.my

A.F.A. Shabudin
e-mail: as_firdaus@usm.my

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that befits the needs of all *stakeholders* (*GAP Priority* 5) today and tomorrow. These examples that enable the campus ecoshere to align itself to the broader priorities of sustainable development and vitalise the university across the board to promote learner centred and solution focused education. The intention of this paper is to share USM's sustainability experience with a wider group of practitioners in the hope that it will enhance action toward GAP and a bigger process of institutional learning for sustainability.

Keywords
Education for sustainable development (ESD) · Higher education institution · Institutional development · University communities

1 Introduction

The world community acknowledges that the present economic development trends are not sustainable, in that it is insufficient to transform the mindset of society towards sustainability. Various societies have different views on how we need to move forward in changing the world towards a "Future We Want". With the vision that education is vital to attaining sustainability, USM has made conscious efforts to transform our curriculum, research agenda, co-curricular and student led activities towards sustainability. As a result, not only USM, many other universities across the world has also been trying to integrate Education for Sustainable Development (ESD) into their curriculum to educate future generations on sustainable development and its components. This global ESD commitment gained further strength when the UNESCO World Conference on ESD launched the Global Action Program (GAP) on ESD in 2015 (UNESCO 2015). With a story line involving selected activities across the university, especially following the beginning of the new millennium, we try to demonstrate how closely some of our efforts have been aligned to the five priority areas of the post 2015 ESD agenda, GAP. Although there is this broad coherence, we are fully aware that when it comes to details there are gaps that need to be bridged and innovative programmes introduced in each of the areas GAP has identified for accelerated ESD action.

2 Background

In line with this year's WSSD-U 2016 theme "Designing Tomorrow's Campus: Resiliency, Vulnerability, and Adaptation", USM aims to support the drive to improve the well-being of humanity, the bottom billion in particular, by educating the graduates in ESD. This generates awareness and understanding that education is

the key to change unsustainable lifestyles and mindsets that are being uncritically promoted currently. USM activities since the new millennium, such as Kampus Sejahtera (Campus well-being) 2000; USM as a Regional Centre of Expertise in ESD 2005; University the Garden concept in 2006 and Award given by Ministry of Higher Education for the Accelerated Program for Excellence (APEX) in 2008, provide a special focus on sustainability education (Universiti Sains Malaysia 2008; Univesiti Sains Malaysia 2013a).

Moving on from the Decade of Education for Sustainable Development and embracing GAP on ESD in 2015 and its five priority areas: (1) policy support; (2) whole-institution approaches; (3) Educators; (4) Youth an (5) local communities, USM has strengthened its commitment to the principles and practices of ESD. This paper highlights five such specific initiatives of USM under: (i) USM Policy on Sustainable Tomorrow, (ii) The APEX sustainability initiative, (iii) Staff participation, (iv) Student programmes and (v) USM-stakeholder engagement, which are aligned to the GAP priorities. The rationale behind this approach is our conviction that in every sustainability conscious university it will be possible to identify a set of programmes and activities that could be linked to the priority areas of GAP. Having had a sort of 'head start', such institutions could identify a host of early action to promote the more specific recommendations of GAP and eventually through gap filling and replication of best practices from across the world, it will be well within the capacity of proactive universities to support global efforts to graduate a set of sustainability leaders. It is in their hands and under their watch sustainability will become a smart way of life that enables tomorrow to be better than today.

The authors of this paper and CGSS/USM have been engaged in a numerber 'process' research that critically analyse the way we have come this far in our sustainability journey, evaluate current standing in relation to regional and global ESD priorities, and project possible trajectories for the promotion of sustainability within higher educational institutions. This approach has taught us that we need to be dynamic to capture each opportunity that our teaching and research provides, network both internally and externally to be in the midst of like-minded academics to mould sustainability infused graduates and be courageous as an institution to be guided by innovative policies and praxis to commit human and financial resources to produce the results we seek. It is hoped that the following sections will provide adequate coverage for what we intent to covey.

(i) USM Policy on Sustainability

Over the years, USM has made strong commitments to internal and international efforts to prevent further irreversible environmental change and sustainable development in its policy and this is in line with the first priority area of GAP i.e. policy support. Recognising that the current global growth paradigm continues to make it harder to set human development on a sustainable trajectory, the university reaffirms the urgent need for its graduates to be fully literate in the knowledge to chart a sustainable future for them. Aligned with the global thinking i.e. WSSD 2002 and

Rio+20 2012, USM has selected water, energy, health, agriculture and biodiversity (WEHAB) as the five major priority sectors, and climate change/disaster risk management, production/consumption and population/poverty as the three cross sectoral areas that form the major sustainability priorities for focused intervention, collectively called 'WEHAB+3' (Universiti Sains Malaysia 2014). The principal approach of 'WEHAB+3' are to,

- Adopt sustainable development as a major guiding principle in the overall operations, including teaching, research, community engagements and institutional arrangements
- Educate USM students with the right blend of knowledge and interdisciplinary skills, suitable for adaptive management, critical reflection and participatory approaches needed for sustainability
- Ensure that research performed addresses environmental, social and economic problems and that efforts are made to translate research findings into policy and public knowledge
- Create an appropriate institutional culture by 'walking the talk' through campus sustainability efforts
- Establish alliance and partnership with relevant stakeholders in the public and private sectors to promote sustainable development, and
- Nurture and educate young people to be leaders and agents of change for a sustainable future.

With such a focus on WEHAB+3, the 'USM Policy on Sustainability 2014' and its implementation ideas such as 'What can USM do to Fast-track Sustainability', 'USM Five-year Plan' and 'Sustainability Capacity building' across USM in four major domains—teaching, research, community engagement and institutional arrangement, USM endeavours to integrate sustainability into all its mission areas. Progress in this process is periodically monitored using the computerized 'Sustainability Assessment Methodology' (SAM) (Sibly et al. 2014).

(ii) The APEX sustainability

Since 2000, USM has embraced ecological protection, conservation of resources and initiatives aimed at promoting campus well-being as a platform for its sustainability transformation. To realize this aspiration, the university has taken steps to refocus and retool its teaching and research program activities toward the need to live within the environmental limits. Those initial steps taken during APEX I will now be accelerated under the APEX II phase (Prahalad 2009).

To promote APEX, USM follows a two-tiered approach. First the university aspires to be world renowned for sustainability. Second, it also aims to be a sustainability-led university (Universiti Sains Malaysia 2008). During APEX first phase USM laid the foundation for the later phase by adopting five critical agendas as its guiding. These are:

1. Transforming higher education for a sustainable tomorrow
2. Creating cutting edge, high value innovative flagships
3. Reaching out towards the bottom billion
4. Translating sustainability into action via the sejahtera concept, and the university in the garden concept
5. Leveraging on scenario planning 'The Blue Ocean Strategy'.

The following are some of the achievements of APEX I highlighted in USM's APEX journey (2009–2013) (Universiti Sains Malaysia 2011),

1. USM APEX university's sustainability strategy, framework and action plan are contained in two important documents: (i) Transforming Higher Education for a Sustainable Tomorrow (informally called the 'Black book' because of its black cover) and (ii) the USM-APEX Sustainability Roadmap (the framework and action plan, called the 'Green book' for its overall green look). While the Black book elaborates the transformations that needs to occur within USM with regard to sustainability integration and reformation, the Green book describes how these changes are to be implemented within the university and identifies the players and their respective responsibilities in achieving USM's sustainability agenda.
2. Turning waste into gold: halal collagen—USM has successfully produced food-grade halal collagen from ovine skin. Ovine skin or sheep skin is considered a bulk waste in Australia and was historically buried or discharged in a manner that would not cause environmental or biological hazard. In partnership with USM and Holista Colltech, the university was able to develop halal techniques and supply the market. A further aspect of the R&D in this research will explore its utilisation for nutraceutical and pharmaceutical applications.
3. Halal Meningococcal Vaccine: Recognising the predicament faced by Muslims around the world, USM has been focusing on building a solid platform for a halal hub. In collaboration with Cuba, we are working on producing and marketing halal tetravalent meningococcal meningitis vaccine.
4. Mobile Teleradiology: Establishing high-tech medical solutions in low-tech environments with the invention of Mobile Extensible Medical Image Analysis and Visualisation Platform (ENDEAVOR-Mobile). The ENDEAVOR-Mobile enables doctors to immediately crowd source expert opinions on critical medical cases from their colleagues, regardless of time and location. It deploys advanced medical imaging technologies developed in USM over several years.
5. The Rubber Genome Project: Given the varied uses of rubber from medicine to transportation and to address the increasing demand for natural rubber globally, research in USM has decoded the first ever draft of the approximately two-billion base genome of the rubber tree using its seamless genome-base discovery platform.
6. Deciphering ancient architecture: The Sungai Batu Archaeological complex is located at the banks of Sungai Batu, one of the confluences of the Merbok-Muda riverine network. Amidst the archaeological complex, consisting of 97 mounds,

containing ancient ruins. Current studies by USM unveiled the function of the excavated mounds as possible jetties, ritualistic monuments as well as iron smelting sites.

7. Malay Braille for the sighted: eKodBraille is the first online multimedia tutorial system with an embedded Braille simulator to teach Malay Braille sighted individuals via the internet. Braille is the primary alternative written communication system for people who are blind. However, in recent years, there has been a dramatic decrease in Braille learning due to reliance on technology such as voice recognition software. Research has shown that technology as a substitute for Braille has left people who are blind illiterate and the Brailles system is currently being taught to children who are blind.
8. Southeast Asia Sustainability Network (SEASN): In connection with the inauguration of SEASN, USM published and distributed three books: (1) A selected literature review of USM research publications on WEHAB+3—summarizes USM sustainability research output on WEHAB+3, mainly during the new millennium, (ii) Post Rio+20 on WEHAB+3: A Southeast Asian perspective—a compilation of articles by different authors from SEASN members institutions on the process and practice of sustainability integration in universities within the context of WEHAB+3, and (iii) Disaster risk management for sustainable development (DRM-SD)—An integrated approach (Koshy et al. 2013)—a comprehensive reference for community leaders and practitioners that treats progressive risk reduction through reactive and proactive approaches to address both natural disasters and major sustainability challenges, as both types present themselves first as risk and then disaster.
9. Sustainability Assessment Methodology (SAM)—SAM nested within the sustainability integration model of USM, was developed by the Centre for Global Sustainability Studies. SAM follows a three stage *input, process, output* methodology. The *input* data could be in the form of course synopsis, research report, project report, article, thesis, dissertation, book, manuscripts, policy documents, action plans etc. This information is analysed during the *processing* step, using 24 key sustainability criteria aligned to the content of the internationally agreed documentation such as, Stockholm Declaration—UN Conference on Human Environment, Brundtland Commission Report, Agenda 21 (UN Conference on Environment and Development—Earth Summit), Earth Charter, Johannesburg Plan of Implementation (UN, World Summit on Sustainable Development), The Future We Want (UN Conference on Sustainable Development—Rio+20) and other relevant national reports from government and civil society reports on sustainability. In the final *output* step, the results are displayed in a variety of ways that appeal to a host of users such as academics, researchers, community or industry project implementers, middle and top level managers and policy makers.

Based on the considerable achievements of USM in laying a strong sustainability foundation during Phase I (2008-2014) of the APEX program, using Blue Ocean Strategy, to transform governance, enhance efficiency of human and financial

resource management, improve infrastructure, boost research and innovation output, and advances in academic reformations, USM entered an ecosphere of APEX Phase II (Universiti Sains Malaysia 2010).

This second Phase aims to produce talents with a global citizen mindset based on the best values, while the enabler will be the core in APEX Phase II, which includes Human Governance, Financial Sustainability, Research and Innovation, Global Citizens, Academic, Services, and Institutional Positioning Agenda. Phase II will move towards the direction of Prominence, Eminence, Relevance and Dominance in all things that we planned for without neglecting the seven thrusts of APEX—The Future, Uniqueness, Sustainability, Humanity, University, Change and Sacrifice (Universiti Sains Malaysia 2013b).

(iii) Staff Participation

In the university context, staff (academic and administrative) are key agents of change for delivering educational responses to sustainable development. In order to promote sustainability and to highlight the need for comprehensive awareness and capacity building, the university needs to integrate ESD into every Responsibility Centre (PTJ), with the aims of improving the PTJ's ability to educate sustainability issues, to conduct and supervise sustainability related research and to organize community engagement. Another useful action area of the university is introducing sustainability lens into professional development programs or activities for academic and administrative staff.

Since employees spend a large portion of their lives at work each day, and creating a culture of employees that value their surroundings and sustainability are vital for sustainability promotion, USM has a special focus on providing adequate space for relaxation, exercise and catering outlets. USM has also organised a series of workshops on sustainability implementation at the workplace for non-academic (management/professional and administration/support) and academic staffs to provide general guidelines for sustainable environmental practices and promote healthy lifestyles.

To address sustainable development issues among university students, academic staff must acquire the necessary knowledge, skills and values on global and national sustainable agenda and develop the requisite motivation and commitment towards a sustainable society. In fact, academician and researchers play a vital role in making professionals in these areas aware of sustainability issues, and ultimately in guiding their decision making processes to support sustainable development. Thus, a 'Sustainability Integration in USM Curriculum Laboratory' has been organized in three USM campuses, Main Campus (Penang), Engineering Campus (Penang) and Health Campus (Kelantan), to integrate ESD elements in teaching, research and community engagement. The program provides a platform for academic staff to discuss and develop ideas on sustainability integration strategy and praxis in the university education system (formal, non-formal and informal). The Post Rio+20 International Conference 2013 was another initiative organized by USM in view of the increasing importance of sustainable development, green economy and SDGs.

As a way forward in the promotion of institutional sustainability the Centre for Innovation and Productivity in Public Administration (PIPPA) was established by USM in 2012. This research-based training centre offers opportunities for lifelong learning for public sector employees in Malaysia and other developing countries. PIPPA plays an important role in translating training into more practical activities to foster innovation, productivity and sustainable culture among USM academic and non academic staff.

(iv) Student Program

Universities with a large cohort of youths, could be a place for catalyzing change to optimize the development of ESD. With this realization, USM envisioned a number of initiatives with regard to formal curriculum development. For example, the elective course on sustainability, WSU 101 (Sustainability: Issues, Challenges and Prospects) for undergraduate students, offered by CGSS, emphasizes hands-on sustainability challenges in a learning by doing mode. At the end of the course, students develop a comprehensive project report which forms part of the continuous assessment for the course. At the postgraduate level, USM has introduced several masters programmes: Sustainable Cities and Communities, Community Medicine-Environmental Health, Sustainable Development Science and Environmental Journalism, Environmental Science, Sustainable River Management, Environmental Engineering and Sustainable Tourism Development. CGSS offers three postgraduate degrees by research; Master of Science (Sustainability), Master of Arts (Sustainability) and Doctor of Philosophy (Sustainability), and also one postgraduate degree by coursework; Master's In Sustainable Development Practice (MSDP). The MSDP is an interdisciplinary program that consists of two years of coursework in four intersecting disciplines such as health science, social science, humanities and management science. There is also a cross sectorial training or internship component, which will require the students to work with communities, industries and government agencies to provide practical solutions and recommendations for addressing the complex development challenges of the stakeholders.

Pimpin Siswa is a leadership program developed by USM since 2009 to provide first year students with experiential training on sustainable living and to develop mostly soft skills. As part of APEX Phase II, a new training module, 'Pimpin Siswa Lestari' (PSL), was introduced in 2015 to ensure that the program outcome aligns with sustainable culture and lifestyle among the students. The module will be mandatory for all first year students as a platform for engaging in issues and innovative solutions for sustainable development. Besides, the implementation of PSL was seen by different departments in USM as a systematic way to introduce students to pursue sustainability goals. Students will be exposed to diverse sources of sustainability components, skills, knowledge and information through PSL which is expected to confer individuals with competency, global mentality and a more competitive & holistic approach to life. Apart from the three traditional triple bottom approach of sustainability, the fourth components Qalbu (in English literally

translated to 'soul') and other generic components of PSL are unique elements which synchronize with certain noble values and characteristics of campus life.

Sekretariat Kampus Sejahtera (Campus Well-being Secretariat) (SKS) is another platforms to instill volunteerism in students and support sustainability related activities on campus. Headed by relatively young enthusiasts at the Vice Chancellors office, SKS is now the major vehicle through which all campus sustainability activities are carried out. There are six clusters of SKS, namely energy efficiency, water conservation, biodiversity, healthy lifestyles, urban agriculture and waste management. The secretariat will give guidance to the USM student community for their commitment and responsibility toward campus sustainability through self-initiatives, proactive team work and volunteerism. In addition, the creation of the Students' Consultative Council of Universiti Sains Malaysia (DPP USM) has led to the establishment of the Youth Parliament, which happened to be the first Malaysia Students' Parliament. The Student's Parliament is one of the best platforms available for students to debate and give their insights on national policies and development issues. It also provides for the enculturation of intellectual debate that will enable the student representatives to hone their skills in conveying ideas objectively, based on facts and evidence (Osman 2010).

The 'White Coffin' (Styrofoam food containers) and 'Say No to Plastic' are two hugely successful on-going student-led campaigns which have spread to other universities resulting in a follow-up activity called Tapau-mania. This program encourages the campus community to bring its own reusable containers to pack food from cafeterias and it also has influenced the Penang state government to implement a 'No Plastic Bag' policy since January 2011. Arizona State University (2009) stated since the launch of the White Coffin campaign in 2007, eight universities have emulated this plan in Malaysia and the Penang state government has also initiated USM's green campaign to eliminate polystyrene foam containers use and to reduce the use of plastic bags in government offices. Even the Consumers Association of Penang (CAP) has cited USM in order to publicly pressure large events such as the Indian festival of Thaipusam to go green. Every year, these events generate almost a million pieces of polystyrene foam waste over three days. As a result, the organizers of these events have committed to switch at least 10 percent of the disposable containers to biodegradable alternatives and have "zero waste" as their long-term goal (Arizona State University 2009).

Volunteerism is an important element in nurturing the holistic development of university students. The new sustainable development goals are firming up, the United Nations Volunteers (UNV) program and its partner organizations are actively engaging to shape the role of volunteers and volunteerism in the global effort to create a better world (Dictus, 2015). USM Volunteer Corps is the result of a combination of 17 different entities. It is a secretariat responsible for ensuring USM governs and manages disaster related issues. An entity known as 'Briged Bencana' (Disaster Brigade), that tackles current issues of disaster within the secretariat. Currently, the Volunteer Corps membership is close to 1500 students. The Corps, based at the IM4U Outreach Center Office, is directly operated and supervised by the Student Affairs and Development Division and the USM Alumni.

A total of 165 volunteer-based programs were successfully implemented by the Volunteer Corps secretariats with participation of 5000 students.

(v) Stakeholder Engagement

For more than a decade, one of the key thrusts in promoting sustainability has been working closely with local and global community through various knowledge transfer programs. USM has a broad view of 'Community', which includes village community, industry, business, NGO/NSA, policy and other similar stakeholders. USM's engagement with these groups is always a "knowledge transfer engagement" to address some pressing development challenges of the stakeholders. The community has a lot of experiential knowledge, developed over a period of time and such knowledge is time-tested and will withstand the pressures of the 'red ocean' world. USM realizes that the sustainability challenges are new and emerging and these communities have little experience yet and, by extension have little knowledge and capacity to face up to them. This is where USM features to responsibly engage with them through knowledge pursuits to help find solutions to their livelihood, business, productivity and governance challenges. In all of these, USM thinks broad and acts local. The examples below will help illustrate how USM is pursuing its mandate to work with community, industry and policy makers.

Under the leadership of the Deputy Vice-Chancellor of Industry and Community Network Division (BJIM), there are a number of industry and community focused partnership projects conducted by students and staffs. One of the popular approaches of BJIM for project implementation is called 'clusters'. While the Disabled People cluster addresses the issues of people with disabilities, the Small and Medium Enterprises (SMEs) cluster focuses on up-skilling SMEs46. The 3C cluster (Corporate Conscience Circle), consisting of a team of multidisciplinary staffs and students working to promote enhanced CSR (corporate social responsibility) and USR (university social responsibility). The University Community Engagement (UCE) Cluster facilitates collaboration between USM staffs, students, as well as alumni for meaningful university community engagements.

USM Innovative Community Engagement refers to organizations and individuals engaging in a process of fostering collaboration which benefits the community. The APEX has promoted initiatives that enhance skills and ability of marginalized and disadvantaged groups. The initiatives include 50 community engagement projects, UCEC 2015, University Community Transformation Centre (UCTC) @ USM, Innovations for Community (INNO4C) and Volunteerism in the Community Engagement (CE). USM-Industry collaboration has engaged direct involvement of around 3000 academicians in various university-industry collaboration projects between 2012 and 2015, largely through the private sector, government agencies, multinational corporations, GLCs, NGOs and likewise.

USM leads and advances its global networks via the Asia-Pacific University-Community Engagement Network (APUCEN), South East Asia Sustainability Network (SEASN), Global Higher Education Network (GHEN), Regional Peace Education for Sustainable Development Network (percent) and

Asian Local Knowledge Network (NS). These networks provide a platform for exchange information and experience throughout the worldwide to develop new ideas in sustainable development. These networks provided opportunities to foster collaboration among members in research, publication, student exchange programme and capacity building programme.

The Ministry of Higher Education in 2010 initiated the 'Knowledge Transfer Programme' (KTP), another major initiative with a 'community and industry' focus with the objective of recognising and promoting knowledge transfer via the exchange of creative and innovative ideas, research findings, experiences and skills between public HEIs, research organizations, industries, government agencies and the wider community. USM was selected as the national secretariat for this programme. Five Key Results Areas (KRAs) of the KTP that will spur industry growth, community development and improve quality of life as a whole, have been identified. They are (a) Education—raising the level of education in certain areas, (b) Economy—economic gain in identifying sectors, (c) Sustainability and Green Technology Initiatives, (d) The Disadvantaged, and (e) Developing Industry/Community Relevant Curriculum (for High Impact Sectors) (Osman et al. 2014). Osman et al. (2016) highlighted that since its inception, 349 projects (industry 219 and community 130) have been implemented throughout the country, with the participation of more than 1400 academic staff, 650 GIs, and 3500 employees from Industry and Community.

In the context of disaster management, sustainability and community engagement, the Centre for Global Sustainability Studies CGSS) actively organising a series of capacity building programmes based on Disaster Risk Management-Sustainable Development (DRM) model developed by CGSS as follows; (a) Training for capacity building—'Disaster Risk Management for Sustainable Development Capacity Building—Malaysia, Vietnam, Lao PDR and Cambodia'. The project is fully funded and supported by the Asia Pacific Network for Global Change Research (APN). A three-day 'learning labs' (for each country) has involved about 60 participants in Malaysia and 30 participants in Vietnam, Lao PDR and Cambodia (b) Training followed by action—'Kelantan Flood Disaster Management Conference, Kelantan, Malaysia'. The conference was attended by about 500 participants consisting of experts from various fields, agencies and institutions of government and non-governmental organizations, academia and also the victims. (c) Consultancy for strategy development for disaster management.—'Workshop on Hospital Disaster Resilience'—A one-day workshop acted as a platform to gather a total of 55 hospital staff as a focus group to discuss the issues related to the 2014 flood as the major concern for the hospital preparedness (d) 'Project for community based resilience building—Reducing Flood-Related Food Security Challenges through ESD in Kuala Nerang, Kedah, Malaysia'—The stakeholders involved in this project consisted of experts from USM, residents, local officials and selected schools in the district. In order to provide better coordination of community engagement, USM now has a dedicated multi-storey building, the Toray Centre for Knowledge Transfer on campus.

3 Conclusion

Since achieving the APEX status in 2008, USM has been actively promoting and implementing ESD through systematic realignment of its priorities, curriculum changes, innovative research approaches, networking, community engagement, and dialogue between the academic community, policymakers and other stakeholders. This expanded sustainability implementation model shows the centrality of ESD in promoting education in its broadest form to build capacity for overcoming major ecological, economic and social challenges in a coherent and interdisciplinary way. In order to consolidate and strengthen engagement USM now has a new 'sustainability policy' which is the result of almost a decade and a half of implementation experience. Policies which are backed by data and success stories are better able to empower institutions to integrate solution oriented action. This realization has been confirmed by the results of the face one the APEX award and its continuation by the Ministry of Education as face two. Part of the lesson that was learned was that unless rhetoric is backed by action even the most grandiose ideas, such as ESD, will not fly high. The diverse activities focused on staff and student at USM have to be seen within this context. The improved autonomy, funding mechanisms, booklets providing ideas for fast tracking sustainability and a computerized methodology to monitor sustainability integration called SAM seem to make collective action that much easier. However, there are still delays and difficulties arising from a mix knowledge, perception, mindset and overall policy applications. The major challenge during GAP will be to overcome these barriers and to enhance the drivers. While there is no illusion that this will be easy, there is also no need to doubt the power of determination and networked action.

We hope that the Global Action Programme, launched at the World Conference on Education for Sustainable Development in Aichi-Nagoya, Japan, will succeed in mobilizing universities to strengthen ESD and provide practical guidance for effective implementation. Consequently, it is hoped that each university and its communities will be empowered to take informed decisions and action for ecological stability, economic progress and social inclusiveness and cultural diversity for the present and future generations. In this context, we are aware of the importance of monitoring and evaluation of our activities in the five GAP areas, as we have described, to promote enhanced ESD practice in Malaysia.

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Weaving the Filigree: Paradoxes, Opposites and Diversity for Participatory, Emergent Arts and Design Curricula on Sustainable Development

David Haley, Valeria R. Vargas and Paolina Ferrulli

Abstract

Evolution and whole systems ecology, thrive on emergent novelty, diversity, and the resolution of opposites. Creative arts and design learning, teaching and research must be encouraged to do the same, otherwise, we risk developing 'art by design, design by statistics and research by bureaucratic policy'. This paper identifies how the space for epistemic complexity is encouraged through a participatory emergent curriculum. As a creative process for teaching, learning and research, this methodology is being developed as a collaborative transdisciplinarity project between Università degli Studi di Firenze and Manchester Metropolitan University (MMU). It includes the schools of Art, Architecture, Science and the Environment, and MMU's Centre for Learning and Teaching to face the indeterminacies of Climate Change and other 21st Century challenges'. Firstly, it presents this approach through case studies highlighting informal, non-formal and formal aspects of Education for Sustainable Development, including ecological arts for 'capable futures', the paradox of sustainable airport

D. Haley (✉)
MIRIAD, Manchester Metropolitan University, Righton Building, Cavendish Street, Manchester M15 6BG, UK
e-mail: d.haley@mmu.ac.uk

V.R. Vargas
School of Science and the Environment and CELT, Manchester Metropolitan University, 1st Floor, All Saints Building, Oxford Road, Manchester M15 6BH, UK
e-mail: v.vargas@mmu.ac.uk

P. Ferrulli
Dipartimento di Architettura (DIDA), Università degli Studi di Firenze, Via di San Niccolò 93, 50125 Florence, Italy
e-mail: paolina.ferrulli@unifi.it

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development, and critical global citizenship through autoethnographic explorations. Then, the synthesis is expressed through the "Walkabout the City?" project that entails the psychogeographic convergence of diverse thinking and physical practice to generate emergent knowledge for urban resilience.

Keywords
Sustainable development · Art and design · Transdisciplinarity · Emergent knowledge

1 Introduction

We live in a complex world. For some this is complicated, challenging and frightening, while for others it is rich, exciting and inspiring. The realities of uncertainty, indeterminacy and chaos rarely figure in 'formal education' at any level, and when they do they are most often presented as abstract or theoretical issues within particular disciplines. However, those realities are central to our well-being and survival. In 1984, Glaswegian artist, Paolozzi, stated that 'what is needed is new culture in which way problems give way to capabilities' (1984). When it comes to identifying such problems within university curricula new capabilities need to be found within Education for Sustainable Development (ESD). Although this article focuses on Art and Design in Higher Education (HE), the context is much wider.

Leal Filho recently discussed three emerging dimensions of sustainability, namely cultural, spiritual, and political/institutional. Within these dimensions, art and design have an important role to play, and this is partly due to their scope for communicating Sustainable Development (Leal Filho et al. 2015). However, creativity may also provide the space for ways to address unsustainability in all areas, which makes it fundamental to encourage innovative thinking in all students (Slahova et al. 2007).

The purpose of this paper is to explore how an emergent participatory curriculum could be co-created across art and design subjects to support sustainable development. To achieve this, the authors synthesize their experiences from three case studies in their project, *Walkabout the City*? It should be noted that this paper explicitly explores some of the intrinsic modes and methods, associated with creative practices in learning, teaching and research. These skills and qualities are finally recognised as necessary to meet the challenges of the 21st Century. In particular, ecological resilience and transdisciplinarity are two key concepts considered for practical sustainability through art and design for Higher Education (Holling and Gunderson 2002; Nicolescu 2002). As the Rumanian physicist, Basarab Nicolescu insists:

> 'It is only if we question the space between, across, and beyond disciplines that we have a chance to establish links between the two post-modern cultures, integrating both science and wisdom. Transdisciplinary Knowledge is able to bring a new vision, not only of academic disciplines but also of cultures, religions, and spiritual traditions.' (Nicolescu 2008).

2 Art by Design, Design by Statistics and Research by Bureaucratic Policy

In the UK, since most schools of art and design became subsumed by the new universities, there has been a trend for standardising essentially creative practices. While no one would complain about maintaining or raising standards, there is a shift in intention and meaning between 'standards' and 'standardising', and this is exacerbated by the language adopted by HE from the commercial and funding sectors.

Distrust of the creative arts, political and scientific misunderstanding has in many institutions replaced studios with 'hot-desking' computers, while courses become unitised, and sanitised to fit spurious Government doctrines of promised employability. And there is pressure on all members of staff to assert 'scientificistic' methods of research on the scholarly explorations of arts practitioners. Of course, the outcome of this massive cultural shift is to produce funding applicators to fit the categories of the politicised Research Councils UK, or to fit the machines of the art markets and design industries.

Despite claims to the contrary, many HE institutions retain or are fortifying their Cartesian silos of knowledge, trying desperately to ignore the plea for curricula reform while being seduced by techno-fix fashions and capricious market economics. As systems thinker and cyberneticist, Bateson pointed out (2000):

> The question is not only ethical in the conventional sense, it is also an ecological question. The means by which one man influences another are a part of the ecology of ideas in their relationship, and part of the larger ecological system within which that relationship exists.

These trends do not bode well for a generation that has to be futures savvy now. To be effective, ESD has to promote resilience and adaptation skills through the core curriculum of every discipline, not tokenistic 'bolt-on' modules. And just as rigor is not confined to Science, creativity is not confined to Art and Design.

3 Diversity and the Resolution of Opposites

It is worth noting the rising in student dissatisfaction. Many students arrive at university with their own top of the range computers, filled with cutting edge software and digital skills that exceed many of their tutors. However, art students

are now asking for life drawing, design students want to learn calligraphy and architects are demanding the return of drawing boards. This is not a nostalgic trip to reassert past practices as a new fashion, nor is it the rise of Art and Design fundamentalism,. This, as French philosopher, Morin, infers is about 'fundamental culture'; a way of thinking, doing and being that sees complexity as reality and the values of social, environmental, economic and cultural justice as being integral to creative expression (2008a). Transdisciplanary researcher, Dieleman, identifies and values this potential (2010):

> Artful doing/knowing is a way to explore and understand reality, not limiting oneself to scientific methods, theory or scientific language. It uses the whole repertoire of human experiences such as images, ideas and practices gained throughout life. It results in insights, visions and symbolic meaning that is communicated through a range of means of communication such as painting, sculpture, interventions, literature, music and the like.

While the impacts we experience, from Climate Change to Information Technologies are accelerating some values remain constant. Author, philosopher, Robert Pirsig contends that: 'Art is high-quality endeavour. That is all that really needs to be said.' (Pirsig 1991). We may, also, look to the essential qualities of life for a way of understanding this emergent understanding and expression of need.

Among the different forms of evolution [natural selection, symbiogenesis, autopoiesis, etc.], a principle element in the understanding of whole systems ecology is diversity (Darwin 1979; Margulis 1998; Maturana and Varela 1998). Here we see the emergence of epistemic knowledge through creative practice. Capra writes (2002):

> '… emergence'… 'has been recognized as the dynamic origin of development, learning and evolution. In other words, creativity—the generation of new forms is a key property of all living systems. And since emergence is an integral part of the dynamics of open systems, we reach the important conclusion that open systems develop and evolve. Life constantly reaches out into novelty.

Novelty, is not to be confused with fashion.

A philosophical concept that may be considered is the resolution of opposites. Breaking from Cartesian dualism is essential if we are to reach a more rounded pluralistic view of the world and the education we practice. This concept has been practiced in many Eastern traditions for centuries. In Zen Buddhism dualism may be resolved in the teaching of *koans*, or paradoxical riddles. In Taoism, the *Taijitu* symbol brings Yin and Yang together as 'YinYang' (Haley 2016). Less esoteric, maybe, but this concept is the crux of this paper, in that it proposes an 'as well as', rather than an 'instead of' approach to what is currently perceived as an educational dichotomy. Here we propose the convergence of three approaches—formal, informal and non-formal methods of art and design education and research. And we see this coming together in the form of participatory emergent curricula as creative processes for teaching and learning. Although it is being directed here to Art and

Design, as a principle, it could be applied to any discipline, and in this way it has the potential to be truly transdisciplinary (Nicolescu 2002). Nicolescu writes:

> The transdisciplinary vision is resolutely open insofar as it goes beyond all the fields of the exact sciences and demands their dialogue and their reconciliation with the humanities and social sciences, as well as with art, literature, poetry and spiritual experience'.

4 Three Case Studies of Education for Sustainable Development in Art and Design

The following, three distinct voices each highlight the merits of formal, informal and non-formal learning, teaching and research in art and design. They come together in the *Walkabout the City*? project, as non-exclusive examples of very different approaches to curriculum development.

4.1 Case Study 1. 'Architectural Concepts of Airport Sustainability' Workshop

The 'Green Airport Design Evaluation' (GrADE) was a doctoral research that investigated issues related to airport project design management complying with sustainability criteria. Project design process represents a complex system of decisions made by practitioners from multidisciplinary fields. The research objective is, therefore, to define methods and tools to facilitate information sharing and evaluation for the effectiveness and efficiency of the decision-making process. Current architectural approaches to airport environmental sustainability tend to focus upon terminal design but a site wide approach to infrastructure design appears to be the key to maximising the environmental capacity or sustainability of a particular airport site (Ferrulli 2015).

This approach included the debate of experts and professionals from multi-disciplinary sectors. As a Ph.D. student visiting the Centre of Aviation, Transport and the Environment (CATE) at MMU, Ferrulli organised and ran a workshop titled *Architectural Concepts of Airport Sustainability* in collaboration with Professor Callum Thomas from CATE and Professor Colin Pugh from Manchester School of Architecture (MSA). The aim of the workshop was to open a cross-disciplinary dialogue between environmental scientists and architects on issues related to sustainable airport project development. Participants included airport specialists, architects, environmental and knowledge transfer experts, professors, lecturers, researchers and students from MSA and Manchester Architecture Research Centre (MARC), the Centre for Excellence in Learning and Teaching (CELT), the Division of Geography and Environmental Management (GEM).

To explore and challenge current design practices and suggest how they can be improved to better address the questions raised from the 'paradox' of sustainable airport infrastructure development, the workshops consisted of two main activities:

(1) a seminar delivered by professors, researchers, doctoral students, and professionals from academia, architecture/engineering consultant firms and the air transport industry;
(2) an open discussion based on the *charette* method. As a model of participation and creativity, the *charette* has huge potential for facilitating the engagement of all participants, supporting dialogue among experts from different fields. The *charette* (Lindsey et al. 2012; Smith 2012):

- provided a forum for the multidisciplinary team of participants who can influence design decisions on an airport project;
- encouraged an advanced dialogue and considerations about the workshop objectives;
- developed consensus and stimulated reflections on the proposed issues.

During the open discussion participants were free to express their opinion based on their academic/professional expertise, as well as their experience as airport users. This approach allowed discussion to expand different topics focused on the central theme of the airport sustainability.

Moreover participants were free to explore and express their ideas in different ways (sketches, schemes, collages, video and slide presentations), see Figs. 1 and 2. It was noticed that through these activities, participants confronted complex themes at different levels (from the urban planning to the technology application).

Fig. 1 Airport is an ecosystem that involves environment, economy, social, culture, politics and regulations. Students compared the airport to the city, applying the adaptability and flexibility of a city to develop and grow over time. Similar to the self-organization of a rainforest, each individual contributes to the system as a whole

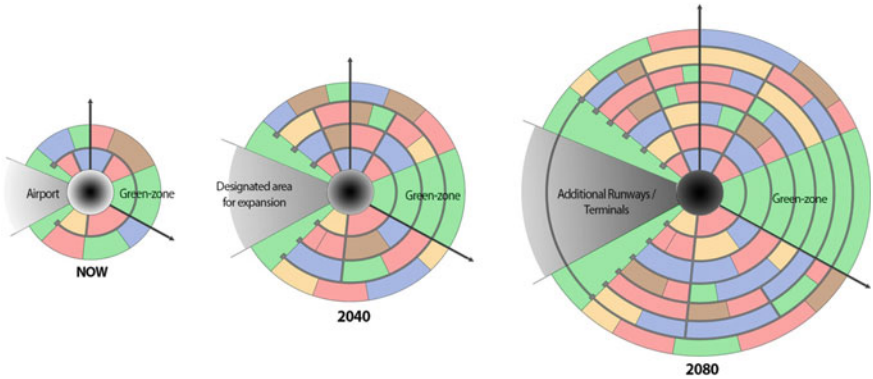

Fig. 2 These diagrams show the development of 'aerovillage' over time. The key aspects are: mixed land-use, building re-use, efficient public transport system, walkable street network, compact urban form, green ecological landscape and energy, and resource efficient systems

Overarching, questions emerged from those discussions, which have become valid support for further research and collaboration between MMU and Università di Firenze.

The formal background of knowledge was investigated through informal approaches structured in non-formal learning situations focused on a clear purpose and organised through a flexible system of activities and methods. This methodology effectively supported the first stages of the GrADE doctoral research, defining the issues and topics of interest while focusing on the final objectives of the research. From a transdisciplinary perspective, the development of sustainability could not be entirely predicted. It was the creative practices that made the space for emergent knowledge.

4.2 Case Study 2. Weaving the Filigree Towards Responsible Futures: A Co-Autoethnographic Exploration

MMU has developed an embedded participatory and reflective approach to a curriculum for ESD, with the *National Union of Students* (NUS) *Responsible Futures* project being one step towards the goal of capable futures at MMU. Through commitments, actions and interventions, this initiative addressed issues of ethics, well-being and environmental stewardship in the formal and informal curriculum. These were assessed against a set of criteria developed by the NUS and the pilot institutions involved in this project.

Reflecting on the approach to this project, it became clear that there is potential to develop links to the community and thereby enrich the student/staff experience. The inter, multi, cross, and trans-disciplinary opportunities offered by this project have become a vehicle for student employability, and student/staff environmental and social action with the local community.

This project, linked to the Society into Higher Education (SRHE) funded research project to explore the potential of the Human Capabilities Approach (HCA) for strategic development in the HE curriculum (Prowse and Vargas 2015). Some interim results from the HCA research project suggested that there is potential to develop a more articulated link between the HCA and ESD by exploring the relationships between Nature and human development and their balance/unbalance through life, and humanity as art. The following workshop was integral to pursuing this creative process of exploration and discovery.

4.3 Aims/Objectives

The aim of the workshop was to explore the sense of identity and agency of human beings in terms of our responsibility within living systems. This was addressed through the different dimensions of the *mochila Arhuaca* (Fig. 3) including symbolic dimensions and the artefact as shelter intertwined with participant led narratives. The *mochila Arhuaca* are hand-crafted bags made by indigenous Colombian women.

Through a short co-auto ethnographic exploration (Ellis and Bochner 2000) led by questions, we approached our humanity.

Fig. 3 Close up of a *mochila Arhuaca* hand made in the Sierra Nevada of Santa Marta Colombia

4.4 Workshop Outline

Participants were asked to do the following:

Activity 1

- Starting with the pronoun *I* write your thoughts on: *Harmony, spirituality and balance of all* (*human and non-human*)
- Place your written thoughts into a *mochila (woven bag)*

Activity 2

- Take a paper from the *mochila* and think how the thoughts written in it by someone else have an impact on your own thoughts. Write down three to five key words about that on the back of the paper.

Activity 3

- Discuss what you discovered from this brief co-auto ethnographic exploration with the people on your table. You can use and share these writing.

The workshop was facilitated with four groups including students, staff from MMU and externally in symposia and seminars. As the nature of this activity was to provide a safe space for people to express emotional concerns related to social, environmental, or spiritual sustainability, the data and feedback from these activities is rich, but difficult to collect without disrupting the workshop. In future, the researchers will design a method to collect and analyse the data to explore the impact and transdisciplinary emergent properties of these activities.

4.5 Case Study 3. Ecology in Practice—Making Our Futures

'Context is all' (Morin 2008b). 12.7 % of the human population live below the poverty line (Randerson 2006). 1 % own more than half of the global wealth (Cohen 2015). Global warming, Climate Change, species extinction, ecological degradation, and diminished resources are facts that we must all learn to live with, but how can art and design address these issues? As well as contributing to knowledge, art has the potential to shift the way we think (Bohm and Peat 2000), but to do this it has to engage the world on an equal, 'post-disciplinary' basis (Meyer-Harrison and Harrison 2008). Putting this concept into practice has driven the interdisciplinary research of Ecology In Practice (EIP) at MMU and one outcome of this inquiry has been the development of 'Question-Based Learning' through the 'Making Our Futures' project-focused *charrettes* over the past eight years (Haley 2011).

Working with undergraduate and postgraduate students, in England, Spain, Taiwan and China, Haley noticed that those from design, architecture and engineering approached the world from a solution-led, 'Problem-Based Learning' perspective,—treating the world as a problematic to be solved. However, those from Fine Arts recoiled from predetermined answers, preferring to ask seemingly unstructured questions. While the arts students initiated their own diverse paths of creative inquiry, the other students awaited a brief. Nevertheless, the design, architecture and engineering students possessed the necessary skills to complete the project, evaluate the work and communicate their findings.

The convergence of these two disciplinary cultures—art and design—could be fraught, but mostly rewarding. Here, formal and informal modes of learning clashed, but through persistence, each project was resolved through non-formal learning that emerged from a common engagement with 'integral, critical, futures thinking' (Slaughter 2004). The future can be frightening, but also inspiring, if seen as an opportunity for convivial participation and creative potential. This project gave students the capabilities to explore their unknown, uncertain and indeterminate futures, to discover their own capacity for resilience and adaptability.

5 A Synthesis Expressed Through the *Walkabout the City*? Project

In November 2015, within the ESRC Manchester Festival of Social Sciences, EIP initiated *Walkabout the City*?, an event with the Università di Firenze Sustainable Airports Project, to create two walks, for thirty multi-sector participants, staff and students from all Faculties. The walks started with one key question, 'How is the city a place to protect and nurture life support systems mow and for the future?' (Prowse and Vargas 2015). Emerging from the relaxed process of walking and talking, MMU's new Birley Fields Campus and the city itself prompted questions of sustainability and the most pressing social, cultural and environmental issues of our time. Visiting the Biospheric Foundation, an intensive farm project created by MMU PhD student, Vincent Walsh, prompted discussion about the viability of urban food. As a psychogeographic convergence of diverse thinking and physical practice, this project saw the emergence of transdisciplinary research being generated by the participants.

Although urban sustainability is relevant to everyone, people rarely have the time and space to question it, but the walks stimulated a *dérive* of futures thinking, ranging from local and international transport to biodiversity, food production, poverty, health, housing, adaptability and Climate Change. Evoking the paradox of *Sustainable Airports,* the walks compared the "passenger experience" of the constructed City Centre at Manchester Airport with the 'real' thing, reflecting on "aerotropolis"—the merging of city and airport that includes contested 'wild' landscapes.

The walks gained wider public participation as they appeared on video linked to a blog, thereby making the space for epistemic complexity, and opportunities for the students on the '*Making Our Futures: ecological arts and sustainable design*', taught MA Art and Design Options Unit to develop their own projects. Also, *Walkabout the City*? prompted the three project leaders to write four refereed international conference papers and journal articles, including this one.

EIP's 'non-formal' research network now includes Universita di Firenze, the ecoart network, Walking Artists Network, UNESCO UKMAB Urban Forum, CIWEM Art & Environment Network, Cultura21, Manchester a Certain Future, and a new online public.

5.1 Methods and Theoretical Underpinning

The aim of the project was to explore how an emergent participatory curriculum could be co-created in art and design subjects to support sustainable development. The concepts of humanity, self, agency and identity were organically incorporated through the walk, probably due to the fact that few had met each other before, and also because of the formal setting. Therefore, people brought personal views to the walk and their identities agency seem to have had a stronger presence than if the discussion had taken place in academia.

A similar approach to the **case study 1** was suggested as part of the *Walkabout the City*? project: inviting people from across the disciplines to challenge and question the methods of investigation, thereby and providing feedback and the potential for further avenues of research.

The concepts of humanity, self, agency and identity (**case study 2**) were organically incorporated through the walk probably due to the fact that not everybody had met each other before, and because they were in a less formal setting. People brought personal views to the walk and their identities had a stronger presence than if the discussion would have taken place in academia.

From **case study 3** the walk was contextualised by 'real world' issues and challenges. Question-based learning provided the core method for arts and design-led, practice-based research into a situation where transdisciplinary knowledge might emerge.

Walking, in practical terms, provided a less hierarchical dialogue within the group which is a fundamental factor for fostering emergent knowledge (Darling 2014). This supports the participatory creation of curricula and the emergent aspect of this exercise to promote ecological resilience and embodied capabilities to adapt to the uncertainties of future indeterminacy, thereby addressing vulnerability perpetuated by myths of certainty and sustaining the values of environmental and social injustice. This, in turn, as Nicolescu comments, has profound ethical and moral consequences.

> Transdisciplinarity Knowledge, TK, corresponds to a new type of knowledge – in vivo knowledge. This new knowledge is concerned with the correspondence between the

external world of the Object and the internal world of the Subject. By definition, the TK knowledge includes a system of values. (Nicolescu 2006).

The walk considered the design differences discussed by Hong and Sullivan between (1) "learning as acquisition", (2) "learning as participation", and (3) "learning as knowledge creation" (2009). The creation of a learning community is one of the main aspects discussed by Hong and Sullivan in relationship to fulfilling the aims of the latter (3). The walk, therefore, focused on the concept of community, permitting the walk guides to engage with it instead of directing the outcomes. This links to the idea of critical global citizenship that suggests that power relations between students and teachers could be softened to give space to a co-created curriculum.

Aligned with principles of ESD, Global Citizenship and HCA, the concept of learning as emergent knowledge (Hong and Sullivan 2009) incorporated the HCA (Wood and Deprez 2012) through the framework developed by Prowse and Vargas (2015). Although early stages of devising the walk were complex, the final design was simple. The single, open-ended question, used at the start of the walk prompted creative, original information (Sproull 1995).

However, one of the main limitations to this study was the on-site data collection. Although the two walks were recorded on video, the sound quality was poor and many of the participants' comments were lost.

Walkabout the City? was not about any one disciplinary perspective, but a way of creating a space for all disciplines to participate in addressing their own capabilities for a collective view of many futures. The future is, thereby opened up as a place for genuine concern and potential creative opportunities, rather than adherence to the unsustainable status quo of perpetual growth development. From this initiative, transdisciplinary knowledge may emerge, and from this a curriculum for 'capable futures' may be formed, but of course there are no guarantees (Haley 2008). To suggest that all the outputs, outcomes and impacts are predetermined would be utterly false, as 'the future is not given' (Prigogine 2008).

6 Conclusion

Excluding informal and non-formal learning from educational variability shrinks the potential for formal teaching to develop ESD across the HE curriculum. As resilience is lost, the system becomes more vulnerable to external shocks (Holling and Gunderson 2002). Of course resilience is like ecology and art, it is an emergent phenomena. It is not a purposive, solution-led, problem-based form or object that can be fixed. It's a dynamic 'quality'. The term 'ecological resilience' is applied to how far a system may be perturbed before it collapses or becomes another state of being (Walker et al. 2006). The capacity to withstand disturbance is not just a question of how long the status quo can be maintained, but how we might emerge in a new world.

Airport infrastructure and definitions of sustainability are also topics the walkers dealt with…. Historically, it is claimed, the structure and organization of transport systems have determined the evolution and changes of human settlements, influencing the design of public space to accommodate nodes and connections (Button et al. 1995; Trinder 2001; Woudsma and Jensen 2003). While walking, participants confronted their relationship to transport and how these systems change the design of and living with a city.

The *Weaving the Filigree…* project created an exchange of emergent knowledge within an ephemeral "community", to become an 'anti-oppressive approach to repetition in education and society' (Kumashiro, in Subreenduth 2013). EIP's *Making Our Futures* created the space for students to discover for themselves that the future is frightening, and inspiring, if seen as an opportunity for convivial participation and creative potential – qualities that all the case studies brought to the walks. Each project, therefore demonstrated the value of synthesizing formal, informal and non-formal practices for teaching, learning, and research. This exploration emerged in *Walkabout the City*? as a means of promoting capable futures for adaptability, and creatively discovered Education for Sustainable Development.

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Author Biographies

Ecological artist, David Haley Ph.D. HonFCIWEM FRSA is a Senior Research Fellow in the MIRIAD Research Centre at Manchester Metropolitan University, UK, where he is Director of the Ecology In Practice research group and leads the MA unit in Making Our Futures—ecological arts and sustainable design. He is a Visiting Professor at Zhongyuan University of Technology, China and a Research Advisor to Transart Institute, USA. David is, also, Vice Chair of the CIWEM Art & Environment Network, a member of UNESCO UK MAB Urban Forum, and Society for Ecological Restoration, Ramsar Culture Network Arts Group, and founding Trustee of Future's Venture Foundation. Prior to his academic career, he was the Creative Director of his own and other companies working in new product design, commercial conference production, community arts development, touring theatre and then celebratory arts with Welfare State International. Projects include: *A Dialogue with Oysters: the Art of Facilitation* (2008-cont.) a new Taiwanese creation myth emerging from the mingling of freshwater and rising seas; *Life Support System* (2012–13), for Hong Kongers to live with Climate Change; *Meantime… Desert Poetics* (2012–13), a poetic mapping of desertification around the world.

Valeria Vargas MA is Education for Sustainable Development (ESD) Co-ordinator at Manchester Metropolitan University and she leads the Environmental Management System policy area on ESD (teaching and learning). Her approach to embedding ESD into the curriculum include appreciative inquiry, and auto ethnographic explorations. Valeria has a multi-disciplinary background and explores transdisciplinarity. She was introduced early in life to Indigenous practices in her home country Colombia. She has extensive experience of living and working amongst unfamiliar cultures to her. Although she has produced and sold sculptures and worked in academic settings, she does not consider herself an Artist, a Designer or an Educator. She does not consider herself a Musician or a Curator. She considers herself a Human, a part of Nature and a born inquirer. Recent projects include:

Leading the National Union of Students (NUS) Responsible Futures project at MMU
Co-researching the "Potential of the Human Capabilities Approach (HCA) for strategy development in the Higher Education curriculum" by Dr. Alicia Prowse (MMU)
Developing the educational proposal "Incorporating Sustainable Wool Processing using Engineering Solutions into the Academic Curriculum" (Winner of the Global Dimension in Engineering Education (GDEE) European Award).

Paolina Ferrulli studied Architecture at the Università degli Studi di Firenze where she graduated with honours in 2012 with a thesis in Architectural Technology and Project Design Management. She worked at the Department of Architecture of the University of Florence from 2010 to 2015, and she contributed to the research on sustainable airport design, defining ad hoc project solutions for the green building compliance and verification tools. Teaching assistant in the courses of Project Design Management and Environmental Design at the University of Florence. Within these

courses Paolina had experience as lecturer addressing topics regarding green building assessment tools and rating systems.

In 2016 she got the Ph.D. in the Architectural Technology & Project Design Management curriculum at the University of Florence, developing a research project—titled 'Green Airport Design Evaluation (GrADE)'—on the topics of environmental design management, sustainable development of airport infrastructure, and building's environmental performance assessment. She was a Ph.D. visiting student in 2014 at the Centre for Aviation, Transport and the Environment (CATE) at the School of Science and the Environment at the Manchester Metropolitan University. During this internship she launched a series of workshops that opened a cross-disciplinary dialogue between environmental scientists and architects on issues related to airport sustainability.

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 disruptive pedagogical framework underpinning these visual cue interventions has been effective in moving learners beyond anthropocentric views of the

T. Tillmanns (✉) · C. Holland
Institute of Education, Dublin City University,
DCU St Patrick's Campus, Drumcondra, Dublin D9, Ireland
e-mail: tanja.tillmanns2@mail.dcu.ie

C. Holland
e-mail: charlotte.holland@dcu.ie

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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) 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-minute 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.

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

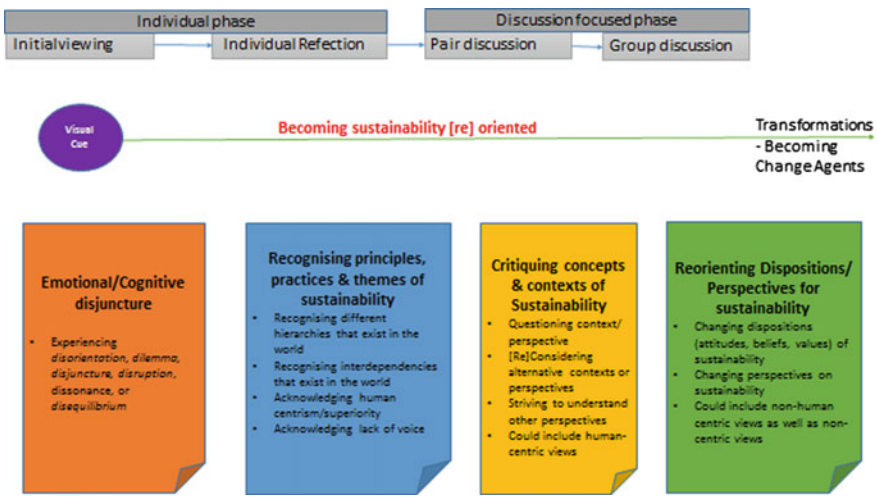

Fig. 2 Pathway to becoming sustainability [re]oriented

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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Author Biographies

Tanja Tillmanns received her Master degree in Management and Organisation Studies from Michael Smurfit Graduate Business School, University College Dublin in 2012. She is completing her PhD studies on disruptive pedagogical strategies within education for sustainability in the Institute of Education at Dublin City University (DCU). Additionally, she has been the coordinator of RCE Dublin since 2014.

Dr. Charlotte Holland is Senior Lecturer in the School of STEM Education, Innovation and Global Studies, and Interim Associate Dean for Research of the Institute of Education at Dublin City University, where she lectures on technology-enabled learning, teacher professional development and Education for Sustainable Development (ESD). She is also Director of RCE Dublin, a Regional Centre of Expertise in education for sustainable development, acknowledged by the United Nations' university in 2014. Her research interests include technology-enabled learning, learning analytics, instructional design, meta-cognition and ESD.

How University Sustainable Development Research Can Impact the Local Community: The Links Between ESD and Dietary Choices

Loraine Spiteri and Mark C. Mifsud

Abstract

As dietary choices vary worldwide and contribute to a distinct identity, this study examined if links exist between various inhabitants' motivating factors, including the environmental impact of meat production and the extent of meat consumption. Such a detailed investigation has never been undertaken at the local level and the results not only shed light on current consumption trends and the perspectives of the inhabitants of two Maltese Districts but also lead to formulate a way forward—Education for Sustainable Development (ESD) being the key to address the current situation for a sustainable future. The quantitative data was collected through a structured telephone survey involving 378 inhabitants from each of the two main islands, with the data then analyzed through SPSS software, employing both descriptive and inferential statistics. This revealed that the absolute majority of participants in both districts are meat eaters although their meat consumption patterns differ in frequency, and in the type of meat consumed. Gozitans lead in their preference for local meat and are more inclined to adhere to the traditional way of life, conforming to religious practices. The absolute majority are unaware of the negative environmental impact of meat production and consumption. This study reveals that geographical location does have an influential role in the dietary patterns of its inhabitants and that environmental attitudes are not a strong deciding factor. This study continues to uphold the vision that culture should be considered as one of the main pillars of ESD. In response to these findings, a model illustrating the

L. Spiteri (✉)
Department of Education, University of Malta, Msida, Malta
e-mail: loraine.spiteri@gmail.com

M.C. Mifsud
Centre for Environmental Education Research (CEER),
University of Malta, Msida, Malta
e-mail: mark.c.mifsud@um.edu.mt

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emerging links between ESD and meat consumption is presented. This paper directly illustrates how university research can impact the local community and the study will undoubtedly prove beneficial to anyone interested in carrying out further research to establish links between ESD and dietary choices.

Keywords
Dietary choices · Education for sustainable development · Quantitative framework · Culture as the fourth ESD pillar · Applied university research

1 Introduction

Every mouthful, every meal, can tell us something about ourselves, and about our place in the world (Bell and Valentine 1997). Food is indispensable for our existence and is in fact found at the base of 'Maslow's hierarchy of needs' pyramid (Heylighen 1992). Food consumption patterns however are not equal for all segments or regions within a given population (Kennedy 2002). In fact, according to Bell and Valentine (1997), it is by exploring geographies of food consumption that we can begin to unpack the role food plays in constituting place identities, giving (post) modern Western societies as an example, where food has long ceased to be merely about sustenance and nutrition—being packed with social, cultural and symbolic meanings as well.

For most of human evolutionary history animal foods have been major components of the human diet (Southgate 1997). Across human cultures, meat is perhaps the most universally valued and sought after source of human nutrition (Beardsworth and Bryman 2004). Globally, around 75 billion land animals were raised for human consumption in 2012 (Food and Agriculture Organization (FAO) 2014) and currently, while livestock supply 13 % of energy to the world's diet, they consume one-half of the world's grain production (Smith et al. 2013). However, cereal grains, which form part of many livestock diets, can be consumed directly by humans (Scollan et al. 2010).

The world food economy is being increasingly driven by the shift of diets and food consumption patterns towards livestock products as over these last fifty years most countries have had a considerable growth in meat consumption per person (FAO 2012). As our global population grows, urbanizes and becomes wealthier, it is demanding more resource intensive, energy rich foods—notably animal products—potentially damaging the environment further and exacerbating problems of obesity and chronic diseases (Garnett 2014). In fact, between 1950 and 2005 world meat consumption registered a six-fold increase, while human population only doubled within that time-frame (Wedderburn-Bisshop and Pavlidis 2011). Moreover, while demand in industrialized countries has reached saturation point, that in the developing world is rising steeply (Chemnitz and Becheva 2014).

Globally, livestock production has responded to a rising demand mainly through a shift from extensive, small-scale, subsistence, mixed crop and livestock production systems towards more intensive, large-scale, geographically-concentrated, commercially-oriented, specialized production units (Robinson et al. 2011)—in other words, a switch from low-input-low-output animal keeping to high-input-high-output animal production (Erb et al. 2012). In fact, to meet the rising global demand for cheap protein, livestock production has become increasingly more industrialized (Brooks 2004).

The livestock revolution was characterized by a rapid growth in production, driven by rising livestock populations and income on the demand side and cheap feed and fuel on the supply side (FAO 2011). This transformation has naturally led to widely available and affordable meat, poultry, dairy products, and eggs (Pew Commission 2008). Yet while land- and water-use efficiency has improved, industrialized farming has led to water pollution and has negatively affected energy consumption and genetic diversity (FAO 2009). Consequently, "the price tag on a package of meat does not reflect the true cost of producing the contents: the hidden costs to the environment and the taxpayer are much higher" (Chemnitz and Becheva 2014, p. 20).

"Livestock's contribution to environmental problems is on a massive scale" and the agricultural sector "emerges as one of the top two or three most serious contributors to the most serious environmental problems, at every scale from local to global" (Steinfeld, et al. 2006, p. xx). The livestock sector currently represents 14.5 % of human-induced GHG emissions worldwide, thus playing an important role in climate change (Gerber et al. 2013). World Wide Fund for Nature's (WWF) 'Living Planet Report' (2012) shows that our individual food choices can also heavily impact the environment and when one takes into account how much food, water, land, and energy is required to raise and transport livestock, it comes as no surprise that meat is considered as having more of an impact on the environment than any other food we consume (Sonesson et al. 2010). In its campaign for sustainable agriculture, Greenpeace (2009, p. 62) emphasizes that "there is an urgent need to substantially reduce over-consumption of meat, eggs and milk … which would also have immediate beneficial health effects".

ESD is the way forward, being a dynamic concept which encompasses a new vision of education, seeking to empower people of all ages to assume responsibility for the creation and enjoyment of a sustainable future (UNESCO 2002). In fact, according to Burlingame and Dernini (2012), information and education about appropriate food choices is essential if the present global situation is to improve, given it is within a sustainable framework. In order to create a sustainable food system it is crucial to cultivate a food culture in which consumers are 'food citizens'—educated to understand the impacts of their food choices on social, ecological and economic sustainability (Lang and Heasman 2004). Although people are aware that their health is affected by the food they eat, the impact that food production and consumption has on the world's resources is less well known (European Commission (EC) 2014).

The way forward to address these challenges is in our hands. Thus, in order to feed a fast growing world population it is necessary to find a balance and ensure a sustainable future for livestock production which will guarantee safe food for humanity, a clean environment, a high standard of welfare for animals and a sufficient income for the livestock producer (Hartung 2013). In addition diets will also need to change. What, and how much we eat directly affects what, and how much is produced. We therefore need to consume more sustainable diets—diets that have lower environmental impacts and are healthier (Garnett 2014), such as the Mediterranean diet which was not only recognized by UNESCO in 2010 as an 'Intangible Cultural Heritage' but was also internationally recognized as a complete and balanced diet pattern, posing to be a sustainable model for the environment as it contributes in reducing GHG emissions related to the production of foods especially meat (FAO 2012).

2 Background to the Study

The Maltese Islands, situated in the central Mediterranean Sea, are comprised of an archipelago of five islands—Malta (246 km^2) being the largest, followed by Gozo (67 km^2). The culture of Malta has been enriched by the many different societies that have come in contact with the Islands throughout history. Gozo bears a number of similarities to Malta, yet is considerably diverse. Being more scenic, greener and quieter than the mainland, Gozo is currently being promoted as an eco-island (National Statistics Office (NSO) 2013a).

According to the 2011 Census the population of Malta nearly doubled from 211,564 in 1911 to 417,432 in 2011. Classified by district, the most populated was the Northern Harbour District (NHD), with 120,449 residents, or 28.9 % of the entire population, compared with 31,375 residents in Gozo, the smallest district. Mainland Malta (1566 persons/km^2) is more densely populated than Gozo (457 persons/km^2) with the NHD (5014 persons/km^2) being the most densely populated (NSO 2014).

Simultaneous to population growth, lifestyle changes developed, leading to a higher quality of life, which in turn led to a higher consumption of different foods. The new food choices however did not always translate into a healthier quality of life. A statistical report conducted in 1839 stated that "the Maltese use very little animal food; bread with the vegetable of the country, and occasionally a little fish, forms their principal sustenance" (p. 20). In contrast, almost 150 years later, the World Health Organization (WHO) (1986) reported that the Maltese diet is unhealthy, being rich in fats and sugar and low in fibre. This shift from the

Table 1 Meat consumption in Malta: 1961–2002 (Brown 2009)

Year	1961	1970	1980	1990	2000	2002
kg/person	34.7	52.7	68.3	71.1	78.6	86.9

traditional Mediterranean diet to a less healthy one is clearly shown in Table 1 which reveals the substantial increase in meat consumption over the years:

This trend continued and Malta's 'Household Budgetary Survey' of 2008 showed that, of the annual budget dedicated to food and non-alcoholic beverages, a typical household spent 21 % on meat, followed by bread and cereals (18.4 %), and fruit and vegetables (18.3 %) (NSO 2010). More recently, the NSO (2013b) reported that the final consumption expenditure of private households on selected food items in 2011 and 2012 was also highest for meat followed by bread and cereals; dairy products and eggs; and vegetables, among others.

3 Education for Sustainable Development in Malta

Sustainable development is crucial for all countries and, even more so, in small islands such as Malta due to the limited resource base and high population density (Mifsud 2012). Malta has led, as well as participated, in international initiatives directed at obtaining global agreements aimed at achieving a world-wide collective effort to guarantee sustainable development—ranging from the Kyoto Protocol to the aggressive leading stance that is being taken by the European Union (Ministry for Resources and Rural Affairs 2012).

In Malta, ESD in the formal, informal and non-formal sectors is mainly addressed by the Education Division, the Malta Environment and Planning Authority (MEPA), the University of Malta and various environmental non-governmental organizations (NGOs) (Briguglio and Pace 2004). Lately ESD was recognized as one of the cross curricular themes of the National Curriculum Framework (NCF) (Ministry of Education and Employment 2012) aimed at making educational institutions sustainable. In a 2011 study entitled 'Maltese Youth and the Environment: A Qualitative Study' a relatively low positive behaviour towards the environment was indicated (Mifsud 2011a). In fact, a comprehensive ESD programme is still lacking in our education system.

It is clearly evident that "education is essential to sustainable development" (UNESCO 2012) as through ESD we can achieve lifestyles based on economic and social justice; food security; ecological integrity; sustainable livelihoods; respect for all life forms; and strong values that foster social cohesion, democracy and collective action (UNESCO 2009). ESD projects not only acknowledge the importance of ESD "to recognise that we must live within the limits of nature's systems" (Centre for Environmental Education (CEE) 2007, p. 4) but people are also simultaneously empowered "to actively participate in shaping an ecologically sustainable, economically efficient and socially just environment, while remaining mindful of the interconnectedness between the local and global dimensions" (Boyadjieva et al. 2008, p. 5).

4 The Role of Higher Education

The Centre for Environmental Education Research (CEER) was set up in 2004 with the intention of acting as a centre of excellence for Environmental Education research in the Mediterranean. The CEER seeks to catalyze change towards a sustainable society by providing opportunities for environmental education that empower citizens, irrespective of age, gender and socio-economic status, to actively participate in environmental decision making fora and in initiatives that promote a good quality of life.

CEER has been promised funds and a building, but, these took a long time to be forthcoming, mainly due to the 'bureaucratic government system' which is prevalent on the island. Nonetheless, CEER has now managed to launch the first Masters in Education for Sustainable Development (MESD) in Malta. This three-year course targets teachers and education experts and aims to provide different perspectives of sustainable development, derived from the interaction of different environmental, societal and economic concerns (Mifsud 2011b).

This course is structured through a philosophy that will enable students to study issues related to ESD in practice and 'in situ' in different environmental realities, and to experience different environmental, social, cultural, political and educational perspectives. Additionally, the MESD helps students to access and critically evaluate ESD research and to develop the skills and attitudes necessary to promote sustainable lifestyles. The MESD also provides structural support for research in the community, and the study presented in this paper is in fact a direct result of this Masters programme, which favours applied research that can actually contribute to the attainment of sustainable communities.

5 Methods

For this study a dual-method grounded approach—quantitative and qualitative—was adopted with the researcher opting for a 'sequential strategy' where the quantitative approach—telephone survey—initially examined facts, and the qualitative strategy—focus groups—was added to explore feelings and perceptions that had not yet been explored in-depth. For the purposes of this paper, only the quantitative part of the research will be considered. The quantitative part entailed the collection of data through a structured telephone survey from among inhabitants of two districts—Northern Harbour and Gozo.

Surveys are useful for acquiring a great deal of specific information (Perner 2010) and usually rely on large-scale data gathering from a wide population in order to enable generalizations to be made about given factors of variables (Cohen et al. 2000). The telephone is an essential tool in survey research, serving both as a frame for drawing samples of households and as a model for contacting and collecting data from household members (Brick and Lepkowski 2006). For this study the

researcher contacted potential respondents by telephone, randomly selected from the telephone directory, in order to ask a standard set of survey questions.

The telephone survey containing 26 questions comprised of three sections:

1st Section The first section involved the collection of socio-demographic data about the respondents, including:

gender, age, status, level of education, occupation, religious affiliation, number of household members.

2nd Section The second section consisted of personal questions aiming to acquire information about:

current meat consumption patterns, factors affecting meat consumption.

3rd Section Questions in the third section were to test respondents' knowledge and perceptions on:

awareness concerning health guidelines related to meat consumption, the negative environmental impact of meat production, economical status associated with meat consumers, perception of meat in comparison to other food items.

With a confidence level of 95 % and a confidence interval of 5 it was calculated that the sample size for each district will be 378 participants and these were randomly selected from the telephone directory according to the locality within the two districts under study. The telephone directory, in fact, served as the sampling frame.

Following data collection, the researcher coded answers into numerically labelled categories and with the aid of statistical software—SPSS statistics—performed quantitative analysis of the data to test theoretical assertions (Groves 1990). The data was tabulated in SPSS to allow for analysis using both descriptive and inferential statistics. The former were created in order to illustrate the telephone survey's findings by converting the responses of each question into percentages. For the inferential statistics the Chi-square test was selected as it allows for the assessment of associations between two categorical variables—in this study mainly

for comparison purposes between the two districts. It was adopted to explore whether significant associations existed between respondents' socio-demographic information and their responses.

The telephone survey served as a vehicle to attain a picture of the current situation among both districts' inhabitants. It was imperative to acquire this data in order to understand the unforeseen and influential factors affecting their meat consumption along with their level of environmental awareness. For local ESD campaigns to be successful, it is fundamental that the current scenario be taken into consideration so that a strategy can be developed accordingly. According to UNESCO (2014), one of the characteristics of education for sustainable development is that it is locally relevant and culturally appropriate. Thus, this study will hopefully be the first step in attaining such goals.

6 Limitations

The telephone directory was used as a sample frame for this study as it is an easy and convenient way to derive a representative sample. However, limitations exist as deriving a sample in this way omits non-telephone owners and those with unlisted numbers (Tanner 2002). Where the Maltese Islands are concerned telephone ownership has increased substantially as the 'Census of Population and Housing 2005' (NSO 2007) reveals that "nearly all occupied dwellings had a fixed telephone line"—131,173—a figure which increased to 141,939 in the latest 'Census of Population and Housing 2011' (NSO 2014). Besides consideration of the cost involved, contacting potential participants on their cell phones was not an option as the researcher was restricted to contact only those residing in the two districts under study.

7 The Findings

This comparative study sought to explore if the uniqueness of both islands is having any influence on the meat consumption of the inhabitants of two particular districts—Gozo and the Northern Harbour. The main outcomes of the study brought to light the popularity of meat among the inhabitants of both districts along with their respective attitudes and behaviours which are mainly influenced by age, gender, geographical aspects, tradition, health and religion.

This study revealed that the absolute majority of residents of both districts do consume meat (Table 2). However, it emerged that the NHD residents consume meat more frequently than the Gozitans as the majority of those who consume meat more than four times per week were from the NHD. A particular similarity which transpires from this study is that the residents of both districts, male and female,

Table 2 Consumption of meat

Do you consume meat?			District		Total
			Gozo	Northern Harbour	
	Yes	Count	377	369	746
		Percentage	99.7 %	97.6 %	98.7 %
	No	Count	1	9	10
		Percentage	0.3 %	2.4 %	1.3 %
Total		Count	378	378	756
		Percentage	100.0 %	100.0 %	100.0 %

$X^2(1) = 6.49$, $p = 0.011$

Table 3 Type of meat consumed

What type of meat do you consume the most?			District		Total
			Gozo	Northern Harbour	
	Beef	Count	64	89	153
		Percentage	17.0 %	24.1 %	20.5 %
	Pork	Count	64	37	101
		Percentage	17.0 %	10.0 %	13.5 %
	Chicken	Count	241	235	476
		Percentage	63.9 %	63.5 %	63.7 %
	Rabbit	Count	5	3	8
		Percentage	1.3 %	0.8 %	1.1 %
	Lamb	Count	0	1	1
		Percentage	0.0 %	0.3 %	0.1 %
	Veal	Count	2	5	7
		Percentage	0.5 %	1.4 %	0.9 %
	Other	Count	1	0	1
		Percentage	0.3 %	0.0 %	0.1 %
Total		Count	377	370	747
		Percentage	100.0 %	100.0 %	100.0 %

$X^2(6) = 15.10$, $p = 0.019$

prefer chicken to other meats due to its nutritive value and its palate. When compared to males, more females prefer chicken while the reverse applies to beef and pork. Interesting to note is that a higher proportion of NHD residents consume beef when compared to Gozitans and conversely a higher proportion of Gozitans consume pork compared to those residing in NHD (Table 3).

In addition, the absolute majority in both districts, even more so the Gozitans, prefer to consume local meat (Table 4). Another interesting factor is that meat consumption is still being influenced on a weekly basis by the religious faith in both districts with more Gozitans abstaining from consuming meat on particular days—Wednesdays and Fridays—throughout the year (Table 5).

Table 4 Preference for local meat

Do you prefer to consume local meat?			District		Total
			Gozo	Northern Harbour	
	Yes	Count	296	254	550
		Percentage	78.9 %	69.0 %	74.0 %
	No	Count	9	16	25
		Percentage	2.4 %	4.3 %	3.4 %
	Local and Imported	Count	70	98	168
		Percentage	18.7 %	26.6 %	22.6 %
Total		Count	375	368	743
		Percentage	100.0 %	100.0 %	100.0 %

$X^2(2) = 9.77$, $p = 0.008$

Table 5 Consumption/non-consumption of meat on particular days

Are there any days when you don't consume meat?			District		Total
			Gozo	Northern Harbour	
	Yes	Count	130	77	207
		Percentage	34.5 %	20.8 %	27.7 %
	No	Count	247	293	540
		Percentage	65.5 %	79.2 %	72.3 %
Total		Count	377	370	747
		Percentage	100.0 %	100.0 %	100.0 %

$X^2(1) = 17.425$, $p = 0.001$

One cannot ignore the respondents' perceptions regarding meat. Meat is valued highly among the Maltese as the majority of participants' ranked meat the highest among the other food groups (Table 6). In fact, respondents considered the main consumers of meat as those of middling socioeconomic status (SES) followed by those enjoying a high SES (Table 7).

The overall opinion is that meat production is not having a negative environmental impact. Results obtained in this study show that only 7.7 % of Gozitans and 6.9 % of NHD residents are aware of the negative environmental impact of meat production, with the majority claiming that cattle rearing is the main culprit. The results are illustrated in Table 8.

Thus, the absolute majority of both Gozitans and NHD inhabitants are not yet totally aware of the full extent of the negative impact of meat production on the environment. In contrast they are very well informed of what constitutes a healthy diet and the majority follow these guidelines. This proves that the various educational health campaigns have been a success. Therefore one can easily assume that should educational campaigns continue to build upon this and simultaneously convey the effects that meat consumption is having on the environment, this too

Table 6 Value of meat dishes in comparison to non-meat dishes

What value do you give to a meat dish in comparison to non-meat dishes?			District		Total
			Gozo	Northern Harbour	
	Very low	Count	4	10	14
		Percentage	1.1 %	2.7 %	1.9 %
	Low	Count	17	22	39
		Percentage	4.5 %	5.9 %	5.2 %
	Average	Count	115	118	233
		Percentage	30.5 %	31.6 %	31.0 %
	High	Count	127	89	216
		Percentage	33.7 %	23.8 %	28.8 %
	Very high	Count	114	135	249
		Percentage	30.2 %	36.1 %	33.2 %
Total		Count	377	374	751
		Percentage	100.0 %	100.0 %	100.0 %

$X^2(4) = 11.70$, $p = 0.020$

Table 7 Meat consumption and social economic status

How do you classify those who consume meat in terms of social economic status?			District		Total
			Gozo	Northern Harbour	
	Very low SES	Count	5	8	13
		Percentage	1.3 %	2.1 %	1.7 %
	Low SES	Count	15	27	42
		Percentage	4.0 %	7.2 %	5.6 %
	Middling SES	Count	273	236	509
		Percentage	72.8 %	63.1 %	68.0 %
	High SES	Count	41	53	94
		Percentage	10.9 %	14.2 %	12.6 %
	Very high SES	Count	41	50	91
		Percentage	10.9 %	13.4 %	12.1 %
Total		Count	375	374	749
		Percentage	100.0 %	100.0 %	100.0 %

$X^2(4) = 9.23$, $p = 0.056$

would be equally successful. If so, one would be following both a healthy and sustainable diet.

From further examination of the statistical results, a model (Fig. 1) that links the inclusion of ESD regarding meat consumption; the promotion of the national Maltese cuisine as it reflects our history, culture and folklore; and the

Table 8 Meat production and the environment

Do you think meat production harms the environment?			District		Total
			Gozo	Northern Harbour	
	Yes	Count	29	26	55
		Percentage	7.7 %	6.9 %	7.3 %
	No	Count	208	234	442
		Percentage	55.2 %	61.9 %	58.5 %
	Don't know	Count	140	118	258
		Percentage	37.1 %	31.2 %	34.2 %
Total		Count	377	378	755
		Percentage	100.0 %	100.0 %	100.0 %

$X^2(2) = 3.57$, $p = 0.168$

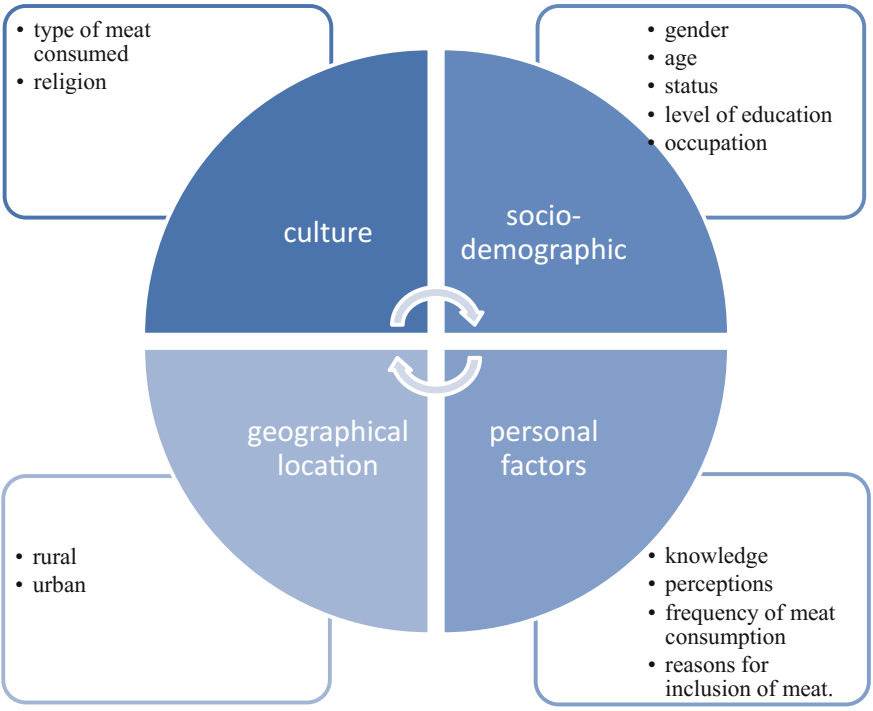

Fig. 1 Factors influencing meat consumption

environmental, economic, social and cultural impact of meat production and consumption is presented. All the main factors that were discovered to be statistically significant in the quantitative research have been incorporated into the model. In addition, in the pursuit of keeping the model as simple as possible, minor areas and other factors which this study identified as being of relative or minor importance

were not integrated. This model is not being proposed with the assumption of being generalized to other sectors of the population or to other geographical locations. This would be an assumption that the current findings would not sustain. Instead it is being presented as a model for the 'particular' not for the 'general'. This line of thought is supported by Courtenay-Hall and Rogers (2002), in their critique of the Kollmuss and Agyeman model when they state that "in sum, modelling research that aims at maximum generalizability while failing to appreciate the particularity of practical knowledge will miss much of what is significant in understanding education" (p. 287).

Meat consumption, being widely consumed across the world in varying degrees, depends on various interrelated factors. This study examined whether geographical location, along with other factors, have a direct effect on the meat consumption of the inhabitants of two Maltese Districts—the urban Northern Harbour and rural Gozo. It transpired that geographical aspects do in fact influence meat consumption as distinct dietary habits emerged. Interesting to note is that the inhabitants of both districts exhibited different lifestyles—those of the Northern Harbour being engrossed in a more modern and busier lifestyle when compared to the Gozitans, who are more inclined towards a traditional way of life in which religion, local produce and cuisine emerged as the main influential factors. Thus culture has an indispensable role as it is part and parcel of one's everyday life. Yet cultural influences vary according to one's age, gender, status, level of education and occupation—aspects which undoubtedly lead to differing perspectives. In turn, one's knowledge and perception are directly linked to the frequency of meat consumption and the reasons for inclusion of meat—balanced diet, palate and variety being the three main determining factors. Thus, this model (Fig. 1) clearly illustrates that meat consumption in the two districts is mainly influenced by the intertwining of cultural, socio-demographic, geographical and personal aspects—all contributing, in their own way, to the extent of meat consumption among the inhabitants of the two Maltese Districts selected for this study.

8 Discussion

The way we prepare, consume, and talk about food says a lot about who we are (Kliewer 2008). There are many personal factors which affect our choices of different foods. Almost everything we eat, and when, and where, is culturally determined (Civitello 2008). This study on the whole reveals that there exist differences between the inhabitants of both districts implying that the geographical location does have an influence on the dietary habits of its inhabitants mainly due to the differences arising from their respective urban and rural characteristics. In fact, according to Horrigan et al. (2002) those who move from rural to urban areas generally increase their consumption, including meat. This study also revealed that the geographical location contribute to different cultural trends—the practice of religion presenting an important example. In fact, according to a local study entitled

'Maltese and Gozitans: A social identity' there exists in Gozo a distinct culture from that which pertains to mainland Malta (Mamo 2012). The social-cultural significance of meat and other animal foods in one's diet is probably the most important determinant of meat consumption (Southgate 1997), a factor confirmed in this study.

One particular factor of importance which emerged was the lack of awareness which exists where the direct relationship between meat production and consumption with the environment is concerned. Education is the only way to address this anomaly. Meat consumption has been addressed in various educational campaigns targeting health with considerable success and it is for this reason, as stated above, that meat consumption must now be intertwined with environmental awareness. According to a study conducted by the University of Cambridge (2014) "maintaining healthy populations, and greatly reducing critical pressures on the environment" will result in double benefits.

9 Recommendations

From the analysis of the results and the construction of the model, a number of recommendations that will lead to a more meaningful link between ESD and meat consumption are being proposed.

1. An inclusive approach

Promoting sustainable diets will require an inclusive approach that reflects the multidisciplinary determinants. Leaders in academia, public policy, civil society, and the private sector from all fields, especially economics, psychology, behaviour change, anthropology, nutrition, environment, climate change, and health and agriculture, are being brought to the table to address the emerging opportunities and challenges associated with sustainable diets (Johnston et al. 2014).

2. A multi-stakeholder task force

This taskforce should include representation from government, civil society, the private sector and academia, and with membership from high-, middle- and low-income countries—should take this agenda forward, developing recommendations where it is possible to do so and identifying priorities for further research (Bailey and Harper 2015).

3. A systematic approach

A systematic approach should go beyond targeting the behaviour of the individual's meat consumption is required as it involves all stakeholders—government, public health bodies, NGOs, food businesses, researchers, environmentalists and

civil society—across a broad spectrum of sectors to develop programmes and policies that promote sustainable diets. Educators and policy makers in the area of education, health and environment therefore have an important task in their endeavour to raise awareness. Campaigners need to address the motivational factors that are leading to the high consumption of meat and one influential underlying factor is the high value being attached to it as for example, the inclusion of various meat dishes on special occasions. Therefore, sustainable consumption campaigns need to address both social and cultural factors—factors which, as this study has shown, cannot be ignored.

10 Conclusion

This research study has helped to form a clearer picture of the Maltese culture where meat consumption is concerned as meat, compared to the past, is now included almost daily as part of the Maltese diet—one can even say that it has become a staple food. The main outcomes of the study brought to light the popularity of meat among the inhabitants of both districts along with their respective attitudes and behaviours which are mainly influenced by age, gender, geographical aspects, tradition, health and religion. This study revealed that the absolute majority of residents of both districts do consume meat. However, it emerged that the NHD residents consume meat more frequently than the Gozitans. Thus it transpired from this study that geographical aspects do in fact influence meat consumption as distinct dietary habits did emerge.

Thus, the differences that emerged between the two districts imply that the geographical location where one resides has an impact, not only on meat consumption but also on perceptions. As a matter of fact Gozitans are more knowledgeable regarding the different aspects of meat production and its related negative environmental impact. The importance that participants have given to their consumption habits in regards to their health has come to light through this study. Therefore one can easily assume that should educational campaigns build upon this and promote traditional Maltese cuisine as part of a sustainable diet and convey the effects that meat consumption is having on the environment, this too would be equally successful. If so, one would be following both a healthy and sustainable diet.

Hopefully this study will trigger necessary action to be taken by the authorities concerned. This first step should ultimately lead to the formulation of official healthy and sustainable dietary guidelines. If successful, not only the health of our nation and the environment will be addressed but we will also be contributing positively to the global environment.

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Authors Biography

Loraine Spiteri is a teacher of Maltese at Maria Regina College—Naxxar Middle School. In recognizing the importance of Education for Sustainable Development and the void which exists in this sphere in Maltese schools, she read for a Masters Degree in Education for Sustainable Development from the University of Malta. Her main research interests focus on distinct cultural aspects and how these influence food preference and consumption together with the related environmental awareness and perceptions. Loraine is also interested in the role Education for Sustainable Development plays in behaviour change, especially in adopting sustainable diets.

Mark Mifsud is a senior lecturer at the Centre for Environmental Education Research at the University of Malta where he co-ordinates the Masters degree in Education for Sustainable Development. Mark also lectures and develops Education for Sustainable Development courses to postgraduate students at the University of Cafoscari, Venice, Italy and at the University of Yaounde in Cameroon. His main research interests lie in environmental education, ESD in formal and non-formal settings, sustainability in teaching and learning and environmental attitudes and behaviour change.

The Development and Evaluation of an Environmental Awareness Course Addressed to Student Tourist Guides in the Maltese Islands

Mark C. Mifsud

Abstract

The study is an evaluation of a new Unit addressed to Tourist Guides entitled —'The Natural Heritage of the Maltese Islands'. The course was carried out through a face to face teaching environment and in the field with student tour guides. This was the first time such a course entered into the tourist guide curriculum in the local context. The main aim of the course was to improve the environmental knowledge and technical abilities of tour guides and increase their awareness on the local environment and on local environmental issues. The study involved the use of a mixed method approach. The qualitative data was supplied through the use of a number of open ended questions in which the students could write down their feelings and opinions, while an extended questionnaire with a number of close ended questions supplied quantitative data. The research also utilized a number of fieldwork sessions in which the participants had to come up with a thematic project that focuses on producing an eco tour for tourists within the Maltese islands. The students then presented their results which were evaluated by their peers. The research identifies a number of areas in which the course was very effective (such as the field visits) while it also highlights a number of areas which require improvement (such as the lack of relevant literature). Overall, the course was found to be very effective in increasing the knowledge, awareness and attitudes of the students towards the natural environment of the Maltese Islands. The individual project was seen as being highly effective in nurturing the skills required by tour guides when performing tour guiding in the natural environment. The study proposes changes to the curriculum currently being thought, and changes in the pedagogy and methodology so as to increase the effectiveness of the course in developing

M.C. Mifsud (✉)
Centre for Environmental Education Research (CEER),
University of Malta, Msida MSD 1252, Malta
e-mail: mark.c.mifsud@um.edu.mt

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tourist guides which are not only knowledgeable and aware of the local environment but which are also able of positively influencing the knowledge, attitudes and behaviour of tourists towards the environment. These changes and the existing and resultant new areas are presented as a model that visualizes the important links which were discovered.

Keywords
Tour guides · Malta · Course development · Environment · Awareness

1 Introduction

The usefulness or otherwise of an environmental awareness module for student tour guides at higher national diploma level has never been studied in the Maltese context. This study is an evaluation of the delivery of the unit and an analysis of student perceptions on this innovative module in the Maltese context. The module was mainly delivered through the use of lectures, a number of fieldwork sessions and the drafting of an original eco-tour by each individual student. The main aim of the module was to improve the knowledge and awareness of the tour guides to the natural environment of the Maltese islands and also to instill skills and education for sustainable development values in the students. The perception of environmental issues, attitude and knowledge of students following such a course is of great importance as knowing what students think about environmental issues will encourage pro-environmental education (Pawlowski 1996) and also because the involvement of students in decision-making and the implementation of environmental and developmental programmes is critical to the long-term success of Agenda 21 (UNCED 1992).

2 Background to the Study

2.1 The Maltese Environment

The Maltese islands are a small archipelago located in the centre of the Mediterranean. The Maltese archipelago comprises three inhabited islands—Malta, Gozo and Comino—with a number of uninhabited smaller islands. The most serious environmental problems arise from the fact that Malta is one of the smallest states in the world and one of the most densely populated. The high population density is augmented further by high tourist arrivals of about 1.2 million yearly (Mallia et al. 2002). The main environmental issues on the island include waste production and

management, reliance on fossil fuels for energy production, high private motor usage and freshwater production requiring a high energy input.

2.2 Tourism in Malta

Tourism is one of the main pillars of the Maltese economy. The Mediterranean climate enjoyed by the Maltese islands tends to make the summer months the most popular among tourists. Nonetheless a large number of tourists still visit the islands due to their cultural and archeological heritage. According to a recent study, 1.7 million tourists visited last year, pumping some €1.5 billion into the economy (Ministry of Tourism 2015). Tourism on the islands creates 27,800 jobs which is equivalent to 1 in 7 jobs in Malta and 1 in every 5 jobs in Gozo. This figure includes both direct job creation as well as the additional 7300 jobs that are created through purchases of operators. Tourism expenditure amounted to €1.5 billion in 2014 which is equivalent to €3750 for every person in the Maltese (Ministry of Tourism 2015).

3 Local Environmental Education Development

Environmental education in Malta started off with environmental NGOs in the 1960s, mainly in response to the major environmental issues on the island. The awareness raising campaign was a very long affair, hindered in its development by a number of factors that lead to the slow growth of environmental education in the islands (Mifsud 2009). These factors include:

- the highly competitive educational system;
- the non-committal policy of the government;
- the colonial mentality.

In the formal education sector one of the major problems is the dominant educational ideology that suppresses creativity and rewards rehearsed words in examinations. Individual teachers who are interested in the environment may attempt to highlight environmental education, but the majority of teachers are hampered with little timetable time and lack of locally produced resources. Some materials currently used in schools were produced for use in other countries, and their transferability in the local context should be cautiously studied (Mifsud 2012).

With regards to the local government, it is apparent that the Maltese government mainly funds projects that have short term goals. Additionally, the lack of a clear national policy on environmental education has resulted in a waste of human resources and the shelving of long-term environmental education initiatives. Due to the fact that Malta was a colony for a long time, a number of anthropologists have indicated that the Maltese people seem to have a problem realising they own the

island itself and its environment (Boissevain 1990). Subsequently, they do not attach much importance to the outside environment. Furthermore, although the Maltese native language is taught and understood by everyone, the English language is still considered to be more prestigious. The situation started to improve mainly in response to the requirements imposed on the country by the European Union. The government is now realising that the environmental education is an effective and long-term solution to ensure environmental sustainability. Many government officials speak of their commitment towards sustainability, but their concern is mainly short-term (Mifsud 2011).

4 Sustainable Development and Higher Education

Sustainable development has increased in importance both as a concept and as process within higher-education institutions in these last years. Such efforts include highlighting sustainability as a key theme within teaching, learning and research policies; increasing course content addressing sustainability; promoting initiatives encouraging sustainable energy and waste practices among students and teachers (Djordjevic and Cotton 2011). Nonetheless, evidence of efforts to include sustainable development related to the tour guide courses within institutes of higher education appears to be limited, with most of the courses having a more general focus. Notable efforts include courses such as those by the University of Manchester which offers a wide range of sustainability courses including courses addressed to hospitality professionals which emphasise positive change rather than on the threats posed by global environmental problems (Dobson and Tomkinson, 2012).

5 The Institute of Tourism Studies and Education for Sustainable Development

The Institute of Tourism Studies (ITS) was established in 1987 and focuses on the changing needs of the Travel, Hospitality and Tourism Industry. ITS aims to produce professional personnel who are able to guarantee an excellent standard of products and services within the Hospitality Industry. The institute provides a range of courses at different levels and aimed at different tourism professionals including in the culinary arts, tourist guiding and in management. The prospects of employment within the tourism industry in Malta are very high, however a number of tour guides prefer to work as ‘freelance’ and therefore develop their own business rather than become employees. Each course is made up of a number of modules and a new module termed ‘Natural Heritage of the Maltese Islands’ was designed, developed and introduced in 2011. The need was felt to introduce this module as much less emphasis was given to the natural heritage in the tour guide

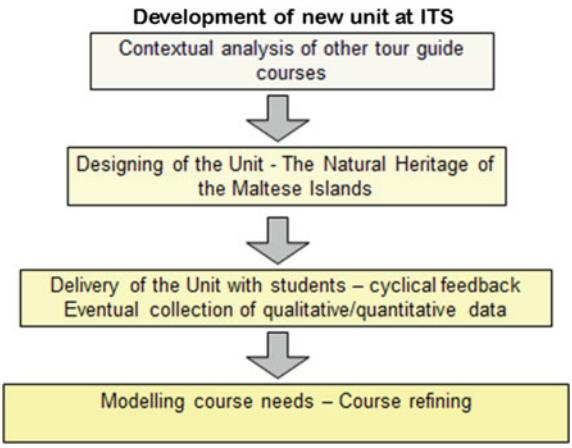

Fig. 1 The developmental process of the Natural Heritage of the Maltese Islands module

course before. Existing tour guides were also continuously suggesting to introduce such a module, as tourists do ask and expect natural heritage information when on tours. Therefore, through a restructuring of the course, appropriate time and structure was afforded for the development of such a unit to address this gap. Figure 1 illustrates the main processes involved in its formation. This particular module and its first participants are the focus the present study.

6 The Module Structure

The module aims at instilling in students the significance of the local natural environment. Natural heritage issues will be discussed mainly from the natural perspective but will also cover other viewpoints including, the social, the economic, the cultural and the aesthetic. The issues presented will be coupled with field observations. The module is structured (see Fig. 2) through a philosophy that will enable students to study tourism related sustainability issues in practice and in different contexts and encourages students to access and critically evaluate research and to develop the skills and attitudes necessary to promote sustainable lifestyles. The unit starts by exposing the students to the main current global environmental issues and then focuses on the local environmental issues which have an impact on the natural heritage. The formation of the Maltese islands together with their geology and geography are discussed in addition to the processes of weathering that lead to the different landforms and valleys around the islands.

The unit then moves on to discuss the nature of life and the various kingdoms present on our planet and lays down the principles of taxonomy and identification. The unit will examine a large number of native, alien and endemic flora and fauna. The various types of ecosystems present in the Maltese islands are discussed, including the specialised habitats like caves and sand dunes. The unit then moves

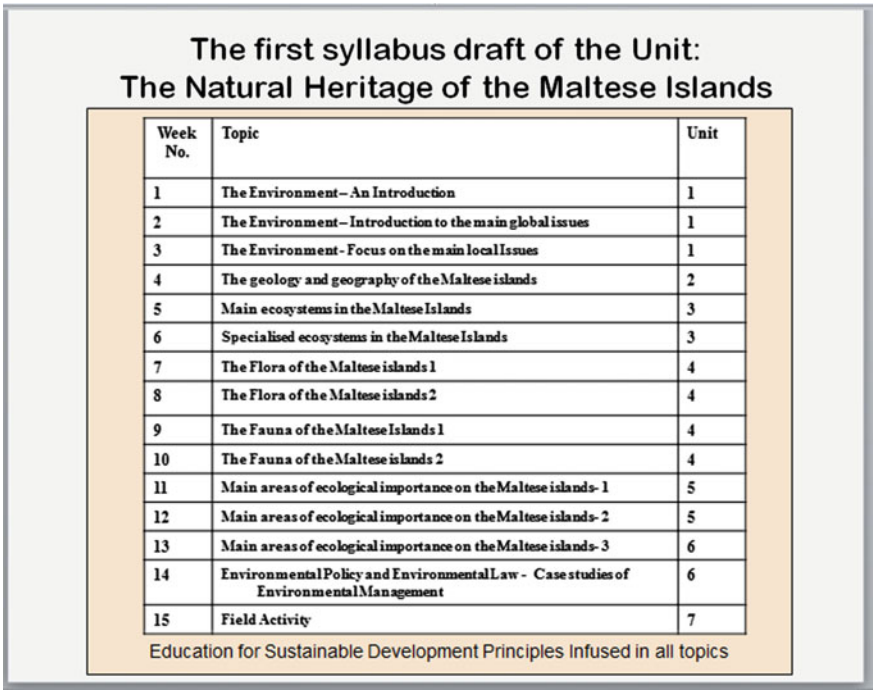

Fig. 2 The structure of the Natural Heritage of the Maltese Islands module

on to discuss the current state of the terrestrial and marine environment with a special focus on the ecology and the landscape. The various types of important natural areas and habitats that are present in the Maltese islands will be scrutinized. These will include important areas such as Natura 2000 sites, nature reserves, important gardens, afforestation areas, the various islands, cliffs and parks. Although the local arena is the main focus of the unit, opportunities will be provided to help students frame local issues within a global perspective. A main component of the course is the project in which the students draft a new eco tour that includes a sustainability trail.

7 The Study

The study involved the use of questionnaires that focused on gathering the general socio-demographic student picture and an in depth student evaluation through open ended questions during term time. The main thrust was to find out how effective the module was being at promoting ESD and what avenues should be taken in order for the module to become more effective. The reponses were categorized and a number of themes emerged. The questionnaire was constructed following the examination

of other instruments in the literature (e.g. Mifsud 2010; Barrett and Kuroda 2002; Eagles and Demare 1999; Gambro and Switzky 1996, 1999; Hodgkinson and Innes 2001; Kuhlemeier et al. 1999; Makki et al. 2003; Mogenson and Nielsen 2001; Fien et al. 2000; Pawlowski 1996; Mifsud 2011). The research identifies a number of different areas which were effective in imparting knowledge, skills or values, while it also highlights areas which can be improved, changed or realigned in order to make the module more effective and operative.

8 Outline of the Methodology

There were sixteen participants in this study which represent the whole cohort of the students following the second year of the tour guiding course in Malta. The participants were forwarded a questionnaire to locate their socio-geographical characteristics, and eventually through a number of open ended questions they were allowed to write their feelings and perceptions. The analysis of the open ended questions was carried through an adaptation of the approach identified by Vaughn et al. (1996) who suggested four processes:

1. *identifying the big ideas—the participants' words and ideas and the intensity with which the participants responded provide an initial framework;*
2. *unitising the data—identifying units of information from the text that will later become the basis for forming themes;*
3. *categorising the units—bring together the units of data identified above that are related to the same content;*
4. *identifying the themes—after considering the big ideas and the categorisation of the units main themes are identified and refined.*

The selection of the 'quotes' to include was informed by a professional judgement of what was important and significant for the context of the study. This, in turn, was based on the considerations of trustworthiness and transparency in qualitative studies, insights gained from the literature and the existing knowledge of environmental education in Malta and the Maltese environmental-political-educational context.

9 Limitations of the Study

One of the limitations of the study was the issue of time management as delivering the questionnaire and collecting qualitative data used valuable course time which had to be continuously sensible to the needs of the students. Another limitation was the effect of the study on the participants responses as the study had to be carried out during the course. This may have influenced the participants to be more sympathetic in their answers to the course parameters. This limitation was partly addressed by carrying out the research after the publication of the assignment results.

10 Socio Demographic Characteristics

Figure 3 illustrates the students' socio demographic backgrounds. A number of trends emerge:

- The majority of students are adult leearners.
- The majority of students were males.
- The students' geographic origin was spread across the islands, but a peak was registered in the Central region.

Fig. 3 Socio demographic characteristics of the students

Age	20-29	30-39	40-49	50-59
Students	50%	25%	25%	0%

	Male	Female
Students	72.5%	37.5%

Geographic Location	Students
South	25%
North	25%
Central	37.5%
Gozo	12.5%

11 The Findings

11.1 Results of the findings from the Quantitative Analyses

No previous study had ever been made on students following the higher national diploma for tour guides. The present study was of a mixed design. A short questionnaire with a number of course parameters was designed in order to give an overview of the course and to act as a precursor to a more 'personal' qualitative analysis. The quantitative results indicate a variety of responses from students in most of the course dimensions which were examined.

Nonetheless, it is clear that students did find that the module was interesting (62.5 % SA and 37.5 % A) and the feedback was effective and useful (12.5 % SA and 75 % A). The course as a whole achieve relatively positive replies in most dimensions, but a relative weakness in the course was identified as the effort required, which was also corroborated in the qualitative analysis. Students appear to be at ease both when working in teams and when working individually. Other areas of the course structure had a positive response such as; course structure and course materials. An illustrative set of quantitative findings from the study are found in Fig. 4.

12 Results of the Findings from the Qualitative Analyses

The present study has brought to the surface quite a range of views regarding the module, its effects and the relation between tourism and the environment in general. With no direct influence from the researcher, the participants introduced several broad themes, the main points of which are summarised below.

13 Main Themes

- Becoming a Change Agent
- Knowledge and attitude changes—a increased sense of pride and belonging
- The eco tour
- Strengths and Weaknesses
- Evolution

	Strongly agree	agree	Not certain	Disagree	Strongly disagree
The module covers the outlined scope, aims and objectives	50%	50%	0%	0%	0%
The module as a whole was well-structured	50%	50%	0%	0%	0%
The intellectual demands made on you were appropriate for the level of the course	50%	50%	0%	0%	0%
Were you satisfied with your own level of preparation and participation	25%	75%	0%	0%	0%
The module materials were adequate	25%	62.5%	12.5%	0%	0%
The feedback was adequate	12.5%	75%	12.5%	0%	0%
Teaching methods were adequate	75%	25%	0%	0%	0%
The availability of reading materials listed in the bibliography was reasonable accessible	25%	50%	12.5%	12.5%	0%
The course was interesting	62.5%	37.5%	0%	0%	0%
The course was difficult	12.5%	25%	12.5%	50%	0%
The course required too much effort	0%	37.5%	25%	37.5%	0%
Adequate support was provided	50%	37.5%	12.5%	0%	0%
The teaching environment was adequate	25%	62.5%	12.5%	0%	0%
Project supervision was adequate.	25%	62.5%	12.5%	0%	0%
Tutor interaction during feedback was adequate	25%	62.5%	12.5%	0%	0%
Group work was effective	25%	50%	12.5%	0%	0%
Individual work was effective	0%	75%	25%	0%	0%

Fig. 4 Selected quantitative results

14 Becoming a Change Agent

A number of students discussed the importance and power in their role as tour guides. They can influence a number of people with regard to the environment. They can show the beauty of nature to others and its fragility. They can change attitudes and they can change values. They are empowered to make changes—effectively becoming change agents.

> *I am already trying to infuse ESD principles in the tours.*
> *We can show simple things to make people change and make a difference to the environment.*

I want to be the change I want to see.
A large amount of people are disinterested in environmental issues … shame. We can change this.

14.1 Knowledge and Attitude Changes—A Increased Sense of Pride and Belonging

The majority of students reported an increase in their natural and environmental knowledge following the course. The increase in knowledge was mainly registered in new identification skills, better understanding of different habitats and on the impacts of humans on nature. This increase in knowledge appeared to make the students more proud of the local natural heritage due to unique endemic species and rare habitats. The ability to link the quality of life with the quality of the environment has become more apparent to the students.

The course has pointed out that the quality of life and the quality of the environment are interlinked.
I am now more able of identifying certain species.
The importance of global and local environmental issues to the tourism industry was made very clear.

15 The Eco-Tour

Many students reported that the eco tour design project was a very important part of the module and that it made them apply what they learnt in the course in a real situation. The eco tour helped students move out of their 'comfort zone' to experience new natural areas and regions. The students also utilised the experience and expertise of various botanists and zoologists to identify the various specimens of flora and fauna they encountered.

I managed to learn a great deal from deigning the tour. I had to go to new natural areas which I had not discovered before.
Through the project I have become more skilled at identifying some local flora and fauna.
The project allowed me to develop new skills in identification and in drafting workable tours in the countryside.

16 Strengths and Weaknesses

Students mentioned a large number of areas which were considered to be strengths and others that were considered to be weaknesses. The following points illustrate the wide ranging strengths and weaknesses as identified by the participants:

Strengths

- Development of a sense of pride, belonging and ownership
- Interesting content
- Very relevant and up to date materials
- The assignment was very hands on
- Sharing knowledge and information with rest of the class

Weaknesses

- Vast syllabus
- Needs to address growing agro-tourism industry
- Needed more suggestions for eco tours
- Sometimes too technical
- Too much material was covered vis-à-vis the credit component

17 Evolution

When discussing their opinion on the future of the module and the local natural heritage in general, most students mentioned that the module should increasingly cover the issue of agro tourism in the tourism industry, an area which was not adequately covered in this initial module. Other students mentioned the importance of increased field visits and some also talked about the importance of reducing some scientific names and detail to make the module more approachable to all students. The importance of intergenerational equity was brought up by a number of students. They referred to the fact that all the local natural heritage should be safeguarded as much as possible in order to ensure that this is enjoyed by our children and their children as well.

The agrotourism industry needs to become a more intrinsic art of the course
That Malta as a small Island includes a number of different fauna and flora and we need to safeguard them for our future generations

18 Conclusions

The research has identified a number different areas that need to be addressed in order to make the 'Natural heritage of the Malltese islands' module more relevant and effective with students who aspire to becoming local tour guides.

These areas include:

1. A more effective and meaningful pedagogy to improve interpretative skills and to better link sustainability and the tour guiding course.
2. A change in the module content to afford increased importance to agro tourism, in particular local practices that highlight the importance of local mediterranean food in order for it to remain sustainable.
3. An increase in field activities—a more practical, hands on approach will lead to a better understanding of how tour guides can infuse sustainability principles in their tours.
4. Streamlining of the module in order to reduce scientific jargon and make the module more accessible to students.

All these suggestions must be examined for incorporation in the next module in order to increase effectiveness. A visual model that illustrates the necessary changes and the current effective mechanisms is illustrated in Fig. 5.

This baseline study identified essential matters that need to be addressed in order to improve the tour guide course and ensure an outcome with increased links between sustainability and tour guiding. The qualitative and quantitative methodology employed to uncover these findings may be applied in other countries following careful contextualization. Further research should be carried out on future student cohorts of this module to further improve the effectiveness of its teaching and learning model. Comparative research with other similar modules in the Mediterranean, European and World regions would help to build a more universal module which should nonetheless be properly contextualized in each region in order to make it more relevant to the different realities.

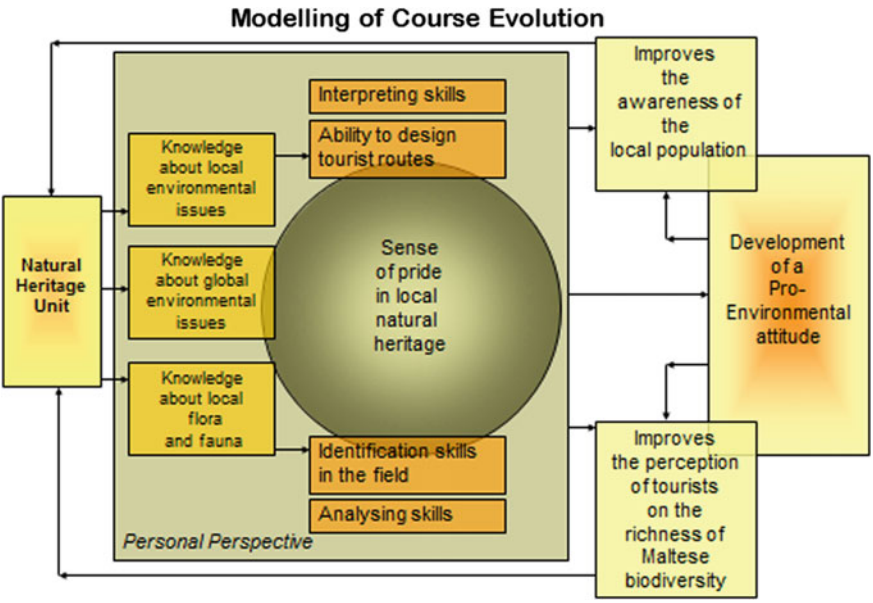

Fig. 5 Tour guiding course modelling

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Author Biography

Mark Mifsud is a Senior Lecturer at the Centre for Environmental Education Research at the University of Malta. He is a Chartered Biologist, a Chartered Environmental Scientist, a Chartered Science Teacher, a Certified Wildlife Photographer and a Prince II Certified Practitioner with more than 20 years experience in Environmental Sciences, Environmental Education and Sustainable Development. Mark is presently the coordinator of the Masters in Education for Sustainable Development and his main areas of research include youth and the modelling of environmental knowledge and behaviour.

Environmental Education in Higher Education Institutions: An Analysis of the Strategies of the University of Southern Santa Catarina to Promote Environmental Education

Jéssica Garcia, Issa Ibrahim Berchin, Gabriel Alfredo Alves Zimmer, Maria Eduarda Medeiros da Silveira, Wellyngton da Silva Amorim, Samara da Silva Neiva and José Baltazar Salgueirinho Osório de Andrade Guerra

Abstract

Environmental education becomes a fundamental key for the construction of a sustainable development, based on conscious consumption and adoption of sustainable actions. This research aims to understand the importance of environmental education policies in Higher Education Institutions. Starting from the guiding principles of the Tbilisi Declaration, a literature review was conducted in order to verify whether the assumptions of the Declaration are corroborated by other authors. This research also presents a case study about the

J. Garcia (✉) · I.I. Berchin · G.A.A. Zimmer · W. da Silva Amorim
S. da Silva Neiva · J.B.S.O. de Andrade Guerra
University of Southern Santa Catarina (Unisul), Florianópolis, Brazil
e-mail: jessica.sgarcia@outlook.com

I.I. Berchin
e-mail: issaberchim@gmail.com

G.A.A. Zimmer
e-mail: gabriel.zimmer.br@gmail.com

W. da Silva Amorim
e-mail: wellyngton8@hotmail.com

S. da Silva Neiva
e-mail: samara_neiva@hotmail.com

J.B.S.O. de Andrade Guerra
e-mail: baltazar.guerra@Unisul.br

M.E.M. da Silveira
University of the State of Santa Catarina, Florianópolis, Brazil
e-mail: dudamaria.ms@gmail.com

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Environmental Education Policies of the University of Southern Santa Catarina. The practices implemented by the University of Southern Santa Catarina and the international literature are compared, ascertaining the importance of implementing strategies for environmental education, as a way to reach the guiding principles of the Tbilisi Declaration and contribute for the formation of more conscious and responsible citizens.

Keywords
Sustainable development · Environmental education · Higher education institutions · Tbilisi declaration

1 Introduction

In recent years, Environmental Education (EE) concern has become more evident in academia, becoming topic of discussion at several conferences such as ECO-92 and Rio +20. With sustainable development being one of the biggest challenges of the twenty-first century, stakeholders are forced to think of new solutions to reduce the impact of climate change. EE began to be implemented in Higher Education Institutions (HEIs) as a way to educate future generations and ensure that economic and social development can take place in a sustainable manner (Xiong et al. 2013).

EE must be seen as a process aimed at building values, behaviors and actions based on the sense of responsibility and sense of belonging to nature. The goal of environmental education is to foster the development of environmental protectors and multipliers of actions guided by knowledge on sustainable development.

HEIs are the pillars to sustain, through mutual learning, the transition towards sustainability (Jones 2013; Ferrer-Balas et al. 2010; Stephens and Graham 2010). Additionally, HEIs provides an experience that will most definitely be crucial in future personal and, most importantly, professional actions (Xiong et al. 2013).

This research aims to understand the importance of environmental education policies in HEIs. Starting from the guiding principles of the Tbilisi Declaration, a literature review was conducted in order to verify whether the assumptions of the Declaration are corroborated by other authors. This research also presents a case study about the Environmental Education Policies of the University of Southern Santa Catarina (Unisul).

2 Guiding Principles of the Tbilisi Declaration

In 1977, UNESCO in partnership with the UN Environment Programme (UNEP) organized the Intergovernmental Conference on Environmental Education. The conference, in its final report, presented the document entitled "Tbilisi Declaration", which took the name of the Soviet city where the conference was held. This Declaration is a landmark with respect to EE, as proposed to clearly define its role, its objectives and its guiding principles (UNESCO 1978a).

The Tbilisi Declaration represented a major breakthrough in the discussion involving environmental education issues. In addition to determining criteria to encourage the spread of EE globally, the statement was also responsible for developing a framework for formal and informal initiatives (Pauw 2014). The following table shows the guiding principles that were agreed at the Final Report of the Intergovernmental Conference on Environmental Education and presents the authors who, through their work, reinforce these guiding principles.

As it is shown in Table 1, the main principles proposed by Tbilisi Declaration are endorsed by current scientific publications on sustainability in higher education, confirming the importance and contemporaneity of these principles.

All these principles are linked, therefore, for the purposes of this study, it was preferred a common and non-specific approach of each principle, precisely to highlight the connections among them and why it becomes difficult to frame or to have a common conception about them, even because, environmental education itself is guided by the principle of interdisciplinary learning.

Considering the extensive goals of environmental education, three different approaches were formulated: education on environment, education in the environment and education for the environment. These approaches should be part of an interdisciplinary curricula component, that is: they should go through teaching in a transversal way, diluted and integrated into different disciplines, in order to facilitate the contextualization and learning about it.

Besides, stating that environmental education should be done in an interdisciplinary way, also implies that it should not be dissociated from an environmental education practice. In other words, it means that, as the University that creates consumers, entrepreneurs, leaders and scholars, it must constantly instigate decision-making and transformation in the subjective level, emphasizing that environmental awareness occurs only when there is individual consciousness, at a foreground.

The guiding principles of the Tbilisi Declaration reflect and instigate a new way of looking at the world. The transition to a path directed to more sustainable practices and lifestyles involves an environmental education that encourages students and society as a whole to develop a closer relationship with nature, only this way environmental ethic, awareness and the pro-environmental skills can be developed.

Table 1 Tbilisi Guiding Principles

Tbilisi main topic	Meaning	State of the Art/Authors
The Environment in its totality	Consider the environment in its totality—natural and built, technological and social (economic, political, technological, cultural-historical, moral, aesthetic)	Mälkki et al. (2015), Mintz and Tal (2014), Azeiteiro et al. (2014), Pitoska and Lazarides (2013), Ghilardi-Lopes et al. (2013), Foo (2013), Adomßent et al. (2013), Manteaw (2012), Khataybeh et al. (2010)
Lifelong Process	Be a continuous lifelong process, beginning at the pre-school level and continuing through all formal and non-formal stages	Azeiteiro et al. (2014), Milutinovic and Nikolic (2013), Adomßent et al. (2013), Ghilardi-Lopes et al. (2013), Urker et al. (2012), Soykan and Atasoy (2012), Khataybeh et al. (2010), Stir (2006), Pacheco et al. (2006)
Interdisciplinary Approach	Be interdisciplinary in its approach, drawing on the specific content of each discipline in making possible a holistic and balanced perspective	Koscielniak (2014), Azeiteiro et al. (2014), Ghilardi-Lopes et al. (2013), Rodríguez-Barreiro et al. (2013), Gaziulusoy and Boyle (2013), Gombert-Courvoisier et al. (2013), Jones et al. (2008), Stir (2006)
National and International environmental issues	Examine major environmental issues from local, national, regional and international points of view so that students receive insights into environmental conditions in other geographical areas	Azeiteiro et al. (2014), Ghilardi-Lopes et al. (2013), Foo (2013), Adomßent et al. (2013), Lozano et al. (2013), Soykan and Atasoy (2012), Zilahy and Huisingh (2009), McDonald (2006)
Current and historical perspective	Focus on current and potential environmental situations, while taking into account the historical perspective	Jayaraman et al. (2015), Hoover and Harder (2014), Koscielniak (2014), Kukeyeva et al. (2014), Barth et al. (2013), Foo (2013), Milutinovic and Nikolic (2013), McDonald (2006)
Cooperation	Promote the value and necessity of local, national and international co-operation in the prevention and solution of environmental problems	Gholami et al. (2015), Müller-Christ et al. (2013), Foo (2013), Adomßent et al. (2013), Manteaw (2012), Soykan and Atasoy (2012), Blum (2008), Pacheco et al. (2006), Steiner and Posch (2006)
Sustainable Development	Explicitly consider environmental aspects in plans for development and growth	Figueiró and Raufflet (2015), Verhulst and Lambrechts (2014), Koscielniak (2014), Hoover and Harder (2014), Lopes et al. 2013, Lozano et al. (2013),

(continued)

Table 1 (continued)

Tbilisi main topic	Meaning	State of the Art/Authors
		Manteaw (2012), Sharifzadegan et al. (2011), Stead and Stead (2010), McDonald (2006)
Participatory learning	Enable learners to have a role in planning their learning experiences and provide an opportunity for making decisions and accepting their consequences	Ghilardi-Lopes et al. (2013), Barth et al. (2013), Soykan and Atasoy (2012), Richter and Schumacher (2011), Rands (2009), McDonald (2006)
Environmental sensitivity towards the learner's community	Relate environmental sensitivity, knowledge, problem-solving skills and values clarification to every age, but with special emphasis on environmental sensitivity to the learner's own community in early years	Azeiteiro et al. (2014), Koscielniak (2014), Milutinovic and Nikolic (2013), Lozano et al. (2013), Manteaw (2012), Soykan and Atasoy (2012), Khataybeh et al. (2010), Blum (2008), McDonald (2006)
Symptoms and causes	Help learners discover the symptoms and real causes of environmental problems	Ghilardi-Lopes et al. (2013), Müller-Christ et al. (2013), Gombert-Courvoisier et al. (2013)
Critical thinking and problem-solving skills	Emphasize the complexity of environmental problems and thus the need to develop critical thinking and problem-solving skills	Kopnina (2015), Mintz and Tal (2014), Posner and Stuart (2013), Gombert-Courvoisier et al. (2013), Khataybeh et al. (2010), Steiner and Posch (2006), McDonald (2006)
Practical activities	Utilize diverse learning environments and a broad array of educational approaches to teaching/learning about and from the environment with due stress on practical activities and first-hand experience	Kopnina (2015), Koscielniak (2014), Lozano et al. (2015), Ghilardi-Lopes et al. (2013), Milutinovic and Nikolic (2013), Müller-Christ et al. (2013), Soykan and Atasoy (2012), Lozano et al. (2013), Jones et al. (2008), McDonald (2006), Pacheco et al. (2006), Steiner and Posch (2006)

Source Made by the authors based on UNESCO (1978b) and in current scientific publications

3 Evaluation of the Unisul's Policy Plan for Environmental Education Based on the Principles Established in the Tbilisi Declaration

Unisul was founded in 1964 aiming to promote education, science, culture, sustainable community and social development through the development and dissemination of technology, performing extension projects, research groups and study projects targeting a more sustainable future and stimulating the development of the

Table 2a Comparison of Unisul's first environmental education goal with the environmental education guiding principles

Goal	Application	Programs	Principles to environmental education
1. Contemplate the Environmental Education Policy on the review of Institutional documents, highlighting the Institutional Development Plan and the Intitutional Teaching Project	Compose papers that contemplate the Environmental Education Policy in Institutional documents	Review of the Institutional Teaching Project and Unisul's Institutional Development Plan	Sustainable Development

Source Made by the authors based on Unisul (2014)

community in its surroundings (Unisul 2015). Considering that, Unisul prepared its Policy Plan for Environmental Education, which states: "at a university, educational activities, research and outreach provide the implementation of environmental education in several social centers" (Unisul 2014).

After analyzing Unisul's EE policies and practices, the authors listed nine goals established by Unisul in order to implement EE in the institution. These nine goals, taken from Unisul's Policy Plan for Environmental Education, were compared and assessed according to the 12 principles of EE indicated by the Tbilisi Declaration and confirmed by the international literature in the area. For this comparison, Table 2 was prepared and divided into 9 tables, from A to I.

Table 2a presents Unisul's first goal for implementing the Environmental Education plan referring to contemplate the Environmental Education Policy on the review of institutional documents, highlighting the Institutional Development Plan-IDP-(Plano de Desenvolvimento Institucional) and the Institutional Educational Project-IEP-(Projeto Pedagógico Institucional). Unisul's first goal on environmental education is in agreement with a guiding principle established by the Tbilisi Declaration, the Sustainable Development.

Unisul's second goal for implementing environmental education refers to the Pedagogical Projects, as shown in Table 2b.

Table 2b presents Unisul's second goal for implementing environmental education referring to the inclusion of the Environmental Education Policy in Pedagogical Projects. Unisul accomplishes this goal through the transversal "Sociocultural Training" certification. Belonging to the institution, since 2013, it seeks dialogue with the socio-cultural differences and addresses the environment and the social and environmental dynamics through social relations of production and consumption. This action is directly linked to the first principle of the Tbilisi Declaration, the Environment in its totality. The implementation of environmental education policies occurs from basic education to higher education through Dehon

Table 2b Comparison of Unisul's second environmental education goal with the environmental education guiding principles

Goal	Application	Programs	Principles to environmental education
2. All Graduation Educational Projects contemplating Unisul's Environmental Education Policy	Inclusion in Graduation Educational Projects	Transversal Certification: Sociocultural Formation; Diversified learning environment in its Program; Environmental Education actions happen since basic education until higher education, in all its levels and categories; Specific Undergraduate Courses	The Environment in its totality; Practical activities; Participatory learning; Sustainable Development; Critical thinking and problem-solving skills; Lifelong Process

Source Made by the authors based on Unisul (2014)

School (complementary Unisul institution offering elementary school, middle school and high school), from undergraduate courses, specialization, master's and doctorate, thus encompassing the second guiding principle, called "Lifelong process".

Finally, Unisul holds specific courses directly related to environmental education, they are: Courses related to EE: Environmental Law; Environmental management; Processing of geographic information in environmental management; Environmental and sanitary engineering; Control of Environmental Pollution Engineering; Environmental education; Environmental management of coastal areas; Masters in Technology and Environment; Analysis and Environmental Landscape Planning and Environmental Education. These courses serve two important principles: Critical thinking and problem-solving skills and Sustainable

Table 2c Comparison of Unisul's third environmental education goal with the environmental education guiding principles

Goal	Application	Programs	Principles to environmental education
3. Approaches on Environmental Education in all its professors and technician capacities	Inclusion of the theme in the Continuing Education Program	Continuing Education Program	The Environment in its totality; Environmental sensitivity towards the learner's community; Symptoms and causes; Critical thinking and problem-solving skills

Source Made by the authors based on Unisul (2014)

Development, since they are creating future professionals in key areas of knowledge and development, who will be prepared to consider the environment in their work.

Table 2c presents Unisul's third goal for implementing environmental education.

Table 2c presents Unisul's third goal for implementing environmental education, regarding approaches on EE in all professors and technicians training. To accomplish this goal, Unisul adopted the Continuous Training Program, which addresses environmental education topics, stimulating discussions focused on environmental recovery and protection of natural resources. This goal is directly in line with four environmental education guiding principles proposed by the Tbilisi Declaration, they are: The Environment in its totality; Environmental sensitivity towards the learner's community; Symptoms and causes; Critical thinking and problem-solving skills.

In turn, Table 2d shows Unisul's fourth goal for the implementation of environmental education.

Table 2d shows Unisul's fourth goal for implementing environmental education, regarding the development of environmental education issues through researches in at least one research group. For that purpose, Unisul supports 10 research groups focused on issues related to environmental education.

Most of these research groups also have external partnerships and cooperation with other universities. This goal is directly related to eight principles of environmental education defended in the Tbilisi Declaration, they are: Interdisciplinary Approach; National and International environmental issues; Cooperation; Participatory learning; Environmental sensitivity towards the learner's community; Symptoms and causes; Critical thinking and problem-solving skills.

Table 2d Comparison of Unisul's fourth environmental education goal with the environmental education guiding principles

Goal	Application	Programs	Principles to environmental education
4. Development of Environmental Education Issues through research in at least one research group	Strengthen projects/research groups focused on Environmental Education issues	Research Groups specialized on Environmental themes	Interdisciplinary Approach; National and International environmental issues; Cooperation; Participatory learning; Environmental sensitivity towards the learner's community; Current and historical perspective; Symptoms and causes; Critical thinking and problem-solving skills

Source Made by the authors based on Unisul (2014)

Table 2e Comparison of Unisul's fifth environmental education goal with the environmental education guiding principles

Goal	Application	Programs	Principles to environmental education
5. Respect for the Environmental Education guiding principles in all Unisul's research projects	Confirm the application of the Environmental Education guiding principles on research projects	Development of research projects related to Environmental Education Educação Ambiental, com funded by research institutions	The Environment in its totality; Interdisciplinary Approach; Participatory learning; Environmental sensitivity towards the learner's community; Current and historical perspective; Symptoms and causes; Critical thinking and problem-solving skills

Source Made by the authors based on Unisul (2014)

Table 2e presents Unisul's fifth goal.

Table 2e presents Unisul's fifth environmental education goal referring to check the implementation of the environmental education guiding principles in the university research projects. This goal is accomplished through the development and implementation of research projects funded by research institutions and directly related to environmental education issues. Some issues addressed by these research projects are: recycling, solid waste, biodiesel, waste energy recovery, sanitary and environmental engineering, sustainable university, treatment and recovery of liquid effluents, environmental preservation and conservation.

This goal is directly related to the following environmental education guiding principles: The Environment in its totality; Interdisciplinary Approach; Participatory learning; Environmental sensitivity towards the learner's community; Symptoms and causes; Critical thinking and problem-solving skills.

Table 2f shows Unisul's sixth environmental education goal.

Table 2f presents Unisul's sixth EE goal, concerning the respect for the EE guiding principles in all of Unisul's outreach projects. To accomplish this goal, Unisul intends to compete annually for the University Outreach Program - PROEXT- (Programa de Extensão Universitária). Table 2g presents Unisul's seventh environmental education goal.

Table 2f Comparison of Unisul's sixth environmental education goal with the environmental education guiding principles

Goal	Application	Programs	Principles to environmental education
6. Respect for the Environmental Education guiding principles in all Unisul's outreach projects	Have outreach projects related to Environmental Education; Confirm the application of the Environmental Education guiding principles in outreach projects; Offer outreach courses on Environmental Education	Unisul competes annualy for the University Outreach Program Execution of transversal outreach projects. Environmental Education Observatory	The Environment in its totality; Interdisciplinary Approach; Participatory learning; Environmental sensitivity towards the learner's community; Current and historical perspective; Symptoms and causes; Critical thinking and problem-solving skills; Practical activities

Source Made by the authors based on Unisul (2014)

Table 2g Comparison of Unisul's seventh environmental education goal with the environmental education guiding principles

Goal	Application	Programs	Principles to environmental education
7. Awareness of all of Unisul's management sectors on Environmental Education Issues	Have an internal Environemntal Education project for all employees	Internal Training Program for professor and employees in all areas	The Environment in its totality; Sustainable Development; Critical thinking and problem-solving skills

Source Made by the authors based on Unisul (2014)

Table 2g presents Unisul's seventh EE goal referring to the awareness of all Unisul's management sectors on the topics of environmental education. For that purpose, Unisul plans to offer annual courses of internal training for professors and employees from all areas, on topics regarding EE. This goal is in line with three principles proposed by the Tbilisi Declaration they are: The Environment in its totality; Sustainable Development; Critical thinking and problem-solving skills.

Table 2h Comparison of Unisul's eighth environmental education goal with the environmental education guiding principles

Goal	Application	Programs	Principles to environmental education
8. Annual Promotion to academia and society in general of the productions on Environmental Education in Teaching activities, research, outreach and Unisul's Management office	Make promotional material of Environmental Education actions	Permanent Highlight at Portal Unisul with the creation of a specific link to present the Environmental Education Policy. Unisul will present and promote its Environmental Education Policy in management meeting, Professors' qualification, academia events and researches	Sustainable Development

Source Made by the authors based on Unisul (2014)

Table 2i Comparison of Unisul's ninth environmental education goal with the environmental education guiding principles

Goal	Application	Programs	Principles to environmental education
9. Monitoring and Assessment of Unisul's Environmental Education actions	Make monitoring and assessment instruments of Environmental Education actions related to learning, research and outreach	The responsible and managers' reports. Creation of assessment instruments to evaluate the inclusion of Environmental Education in teaching, research and outreach	The Environment in its totality; Sustainable Development

Source Made by the authors based on Unisul (2014)

Table 2h presents Unisul's eighth environmental education goal.

Table 2h presents Unisul's eighth EE goal, regarding the annual promotion of productions on EE in Unisul's Teaching, Research, Outreach activities and Management to the academic community and society in general. This goal is directly related to a principle of the Tbilisi Declaration, the Sustainable Development.

Table 2i presents Unisul's ninth environmental education goal.

Table 2i presents Unisul's ninth environmental education goal, regarding the monitoring and evaluation of Unisul's EE action. This goal is accomplished through reports of the managers in charge; creation of assessment tools to measure/assess the inclusion of environmental education in teaching, research and outreach.

This goal is directly in line with two guiding principles of environmental education highlighted in the Tbilisi Declaration: The Environment in its totality and Sustainable Development.

4 Conclusions

The literature review showed that the principles of Tbilisi are strongly supported by the international scientific literature, and can be used by HEIs to create EE plans on their curricula. The principles with highest support by international scientific literature are Practical activities and the Interdisciplinary Approach, both considered and implemented by Unisul's EE policy.

The case study shows that the EE Policy, a document created by Unisul, is in line with the principles of the Tbilisi Declaration. In addition, the case study showed that Unisul sets a model regarding outreach projects and research groups focused on the environment, encouraging cooperation not only among universities, but also with the population of the region in which it is located.

The outreach projects promoted by Unisul are an example of good practices for EE, by involving students, professors and the community in a common environment, learning and teaching each other. In the same way, the research groups in Unisul, focused on environmental concern and sustainability issues are cooperating with other institutions, sharing experiences, methods, knowledges and technologies.

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Authors Biography

Jéssica Garcia BA in International Relations at the University of Southern Santa Catarina. She also participates in the projects LINKS 2015—Linkages between energy, food and water consumption in the context of climate change mitigation strategies, and BRIDGE—Building Resilience In a Dynamic Global Economy: Complexity across scales in the Brazilian Food-Water-Energy Nexus funded by FAPESC and the Research Council of United Kingdom (RCUK) through Newton Fund. E-mail: jessica.sgarcia@outlook.com.

Issa Ibrahim Berchin Master's student in Administration at University of Southern Santa Catarina, Brazil. Bachelor in International Relations at the University of Southern Santa Catarina, Brazil. In Unisul he is a researcher at the Research Group on Energy Efficiency and Sustainability —GREENS. He also participates in the projects LINKS 2015—Linkages between energy, food and water consumption in the context of climate change mitigation strategies, and BRIDGE—Building Resilience In a Dynamic Global Economy: Complexity across scales in the Brazilian Food-Water-Energy Nexus funded by FAPESC and the Research Council of United Kingdom (RCUK) through Newton Fund. At Unisul, he was a junior research in REGSA Project—Promoting Renewable Electricity Generation in South America. As well as in GIPART—Interdisciplinary Research Group. He worked as Project Manager for Social Programs at AIESEC Association Internationale des Etudiants en Sciences Economiques et Commerciale. Unisul, Rua Trajano 219, Florianópolis, Brazil. E-mail: issaberchim@gmail.com.

Gabriel Alfredo Alves Zimmer Bachelor's in International Relations at the University of Southern Santa Catarina. He also participates in the projects LINKS 2015—Linkages between energy, food and water consumption in the context of climate change mitigation strategies, and BRIDGE—Building Resilience In a Dynamic Global Economy: Complexity across scales in the Brazilian Food-Water-Energy Nexus funded by FAPESC and the Research Council of United Kingdom (RCUK) through Newton Fund. E-mail: gabriel.zimmer.br@gmail.com.

Maria Eduarda Medeiros da Silveira Bachelor's in Law at the University of the State of Santa Catarina. She also participates in the projects LINKS 2015—Linkages between energy, food and water consumption in the context of climate change mitigation strategies, and BRIDGE—Building Resilience In a Dynamic Global Economy: Complexity across scales in the Brazilian Food-Water-Energy Nexus funded by FAPESC and the Research Council of United Kingdom (RCUK) through Newton Fund. Email: dudamaria.ms@gmail.com.

Wellyngton da Silva Amorim Bachelor's in International Relations at the University of Southern Santa Catarina. He also participates in the projects LINKS 2015—Linkages between energy, food and water consumption in the context of climate change mitigation strategies, and BRIDGE—Building Resilience In a Dynamic Global Economy: Complexity across scales in the Brazilian Food-Water-Energy Nexus funded by FAPESC and the Research Council of United Kingdom (RCUK) through Newton Fund. E-mail: wellyngton8@hotmail.com.

Samara da Silva Neiva Bachelor's in International Relations at the University of Southern Santa Catarina. She also participates in the projects LINKS 2015—Linkages between energy, food and water consumption in the context of climate change mitigation strategies, and BRIDGE—Building Resilience In a Dynamic Global Economy: Complexity across scales in the Brazilian Food-Water-Energy Nexus funded by FAPESC and the Research Council of United Kingdom (RCUK) through Newton Fund. E-mail: samara_neiva@hotmail.com.

José Baltazar Salgueirinho Osório de Andrade Guerra Ph.D. in Political Science and International Relations. Professor in the University of Southern Santa Catarina (Unisul). Also in UNISUL, he coordinates three research projects: JELARE—Joint European-Latin American Universities Renewable Energies Project; REGSA—Promoting Renewable Electricity Generation in South America, both funded by the European Union (through the ALFA III program and the thematic program for the environment and sustainable management of natural resources including energy); Projects Links 2015—Linkages between energy, food and water consumption in the context of climate change mitigation strategies and BRIDGE—Building Resilience In a Dynamic Global Economy: Complexity across scales in the Brazilian Food-Water-Energy Nexus, funded by FAPESC and the Research Council of United Kingdom (RCUK) trough Newton Fund. Leader of the Research Group in Energy Efficiency and Sustainability. He was a member of the Scientific Committee of the World Symposium on Sustainable Development in Universities (WSSD-U-2012 and WSSD-U-2014), a parallel event to Rio+20 and the Green Campus Summit 2013. He is the former Dean from Unisul Business School, author and organizer of several books in the areas Economy, Environment, International Relations, Sustainability and Renewable Energy. E-mail: baltazar.guerra@Unisul.br.

Building the Platform: Supporting a Sustainability Agenda and University-Community Relationships

B.D. Wortham-Galvin, Jennifer H. Allen, David Ervin and Jacob Sherman

Abstract

Portland State University's (PSU) faculty and students routinely put into practice the University's motto, "Let knowledge serve the city". This chapter presents the early efforts and the role PSU faculty, students, and administrators have played in local, state, national and international sustainability movements. Importantly, it reviews the pathway and reasoning behind the critical decisions to create a campus wide, cross cutting initiative integrating sustainability across the campus in academic programs, centers of community service, and PSU's own footprint. Emphasis is placed on the diverse and innovative sustainability projects and processes across a variety of educational programs in order to document and disseminate best practices in multi-disciplinary community-engaged teaching and research with a focus on sustainability (cultural, social, economic and/or ecological).

B.D. Wortham-Galvin (✉)
School of Architecture, Center for Public Interest Design,
Institute for Sustainable Solutions, Portland State University, Portland, USA
e-mail: bdw3@pdx.edu

J.H. Allen
College of Urban and Public Affairs, Institute for Sustainable Solutions,
Portland State University, Portland, USA
e-mail: jhallen@pdx.edu

D. Ervin
Emeritus of Environmental Management of Economics, Portland State University,
Portland, USA
e-mail: ervin@pdx.edu

J. Sherman
Institute for Sustainable Solutions, Portland State University, Portland, USA
e-mail: jsherman@pdx.edu

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1 Introduction

The rapid expansion of the American Association for Sustainability in Higher Education (AASHE) suggests that academia is accepting the challenge to integrate sustainability considerations into its research, teaching and operations. In 8 years of operation as a national organization, AASHE has grown to 840 member schools (AASHE 2014). While this burst in interest is impressive, the development of successful academic sustainability programs poses three nontrivial challenges. First, the scientific theory and methodology to conduct sustainability scholarship in teaching and research remains nascent. A large eclectic literature has emerged on sustainability over the last few decades, including National Research Council reports that have helped to lay a foundation for understanding the scope of this field (e.g., NRC 1999, 2014). However, a tight paradigm that would provide a common foundation and methods for analysis has not yet evolved. While that diversity may reflect the all-compassing nature of the topic, it leaves the field in a considerable state of flux (Clark and Dixon 2003). Without clear guidance, academic institutions generally 'learn by doing', an exercise in adaptive management that can be successful but also involves missteps and corrective actions.

Second, implementing successful academic sustainability programs requires new institutions and organizational developments to foster interdisciplinary and transdisciplinary scholarship. Although the National Science Foundation has sponsored such efforts [e.g., the Integrative Graduate Education, Research and Training (IGERT) and Research Traineeship (NRT) programs], academia—and especially its governance structures—is still dominated by individual disciplines. Third, sustainability scholarship generally involves interdisciplinary systems approaches to wicked problems (Rittell and Weber 1973; Batie 2008) that impose high upfront costs. This in turn requires seed funding for investments in cross disciplinary integrative teams. Although such approaches arguably yield more systemic and durable solutions to today's vexing issues, sources of funding for such efforts are few.

Within this contextual frame, this chapter tells the story of building the platform for sustainability programs at Portland State University (Wortham-Galvin et al. 2016). There has been a rapid increase in academic sustainability programs in the U.S. and overseas as well as increasing evidence that community-engaged learning is a particularly powerful experience for students and faculty. As both enrollment and budget pressures grow in higher education, we believe universities, their communities, and governing and funding organizations can learn valuable lessons from Portland State University's approach, our successes, and perhaps even more

from our continuing struggles in sustainability programming and community-engaged scholarship and teaching. However, some overarching principles can assist that journey and avoid wasting valuable resources while improving progress in addressing escalating sustainability problems and forging successful university-community partnerships.

It is important to stress that Portland State University is a comparatively young university, especially in research capacity. Founded as an extension college in 1946 to serve veterans of World War II, PSU only achieved university status in 1969. This relative immaturity as a research institution carries both advantages and limitations in building academic sustainability programs, as we will demonstrate in this volume. Despite its youth, PSU has been a leader for decades in creating educational programs consistent with sustainability principles. For example, PSU launched the nation's first multidisciplinary environmental science Ph.D. degree in 1971. Since 1994, PSU's general education "University Studies" program has been organized around interdisciplinary approaches that advance students' abilities and understanding related to inquiry and critical thinking, communication, diversity, ethics, and social responsibility. The legacy of these early commitments to interdisciplinarity may well have set the stage for the acceptance by faculty, administrators, staff and students of more recent sustainability programming.

PSU also had a distinguished history of community engagement and problem solving, core elements of implementing successful sustainability programs. Consistently ranked in the top ten U.S. universities for its service learning efforts, PSU takes seriously the education of its students through experiential learning (Shandas and Messer 2008). The development of PSU's sustainability programs and its community engagement in this context documented throughout this chapter has been a process of ongoing learning and adaptation toward achieving our long term aspiration to be a national leader in sustainability scholarship (Wortham-Galvin et al. 2016). While substantial progress has been made, challenges remain. Here we offer observations on the overarching learned lessons that emerge from the preceding chapters, in the hopes that they may be useful to other institutions pursuing sustainability as an institutional priority.

2 Building the Platform

The PSU story is essentially one of adaptive management because uncertainty pervades the field of sustainability, meaning that both targets and methods require periodic revision based on emerging information and learning. As often happens at universities, student activism was an instrumental driver in the early stages of sustainability programming at Portland State University. In 2000, a group of students assembled to voice their dissatisfaction with the state of recycling on campus, forming an ad hoc group to investigate potential improvements and recommended using some of their student fees to finance a new position in campus operations in charge of sustainability activities. The Student Senate approved their

recommendation and the Vice President for Administration and Finance matched their commitment with additional funding, maintaining this pledge despite tough budget cuts in 2000–01. PSU's first operations sustainability coordinator started in the fall of 2001, after a national search that attracted over 100 applicants.

Lesson 1: Early leadership by students and administrators were key elements in successfully launching sustainability programs.

Despite the growing portfolio of sustainability research projects and rising demands by students and community partners to do more such projects, there was little institutional capacity to coordinate and leverage such efforts across campus. Recognizing this void and the unrealized opportunities it represented, in 2001 two faculty members (including co-author David Ervin) met with several deans to propose hiring an academic sustainability coordinator so that there would be someone who would, as the faculty members saw it, "wake up every day thinking about how to advance PSU's academic sustainability programs". The deans endorsed this proposal, recognizing that the Portland region was gaining a national and international reputation for developing innovative sustainability institutions and practices, and that PSU had an obligation to assist public and private entities in achieving their sustainability aspirations—consistent with the university's motto, "Let Knowledge Serve the City".

Ervin was selected as the first Coordinator of Academic Sustainability Programs (CASP), starting in this role in September 2002. In addition to the CASP's half-time salary, the Provost and the Office of Research and Sponsored Projects provided a small operations budget and support for two graduate assistants; while this limited resource base forced a lean approach focused on building social networks on and off campus, these relationship-focused strategies yielded significant dividends in the long run. The position's main responsibilities were to identify the various strands of sustainability scholarship on campus (including pockets of excellence that could grow with additional support), facilitate dialogue among faculty, students and community partners on potential academic scholarship initiatives, and work with the operations sustainability coordinator to make the campus a laboratory for education, research and community outreach.

Lesson 2: Early investment in developing social capital across the campus community to engender trust—an essential but often neglected component of effective sustainability programs—can pay long-run dividends.

Defining the relevant boundaries and content that sustainability programs should encompass is a common and ongoing challenge for these programs, as sustainability concepts can include the natural and social sciences, engineering, professional schools, the humanities and the arts. An important early step to help define PSU's sustainability focus was to conduct an on-line survey of faculty in early 2003 to inventory existing research projects, courses, and outreach programs that had 'significant' sustainability content. Lacking a precise set of criteria and metrics to

judge relevance to sustainability, the survey offered a general description of core sustainability concepts, and allowed responding faculty to judge whether their work fit. It was clear that this process would likely capture more activities than PSU could reasonably support if we were to succeed in bringing rigor and focus to the sustainability programs. However, the process was important to identify faculty members who felt they were involved in sustainability-related scholarship and to begin the process of building a social network of campus scholars who could contribute to program development. The survey findings were categorized under common themes such as urban planning, water resources, business sustainability, and several others, and respondents were invited to provide feedback on these themes through a sustainability website. Using a fairly open-ended approach to collect a broad base of information and then iteratively refining PSU's areas of focus represented the important sustainability principle of using adaptive management when faced with such uncertainties (Castle et al. 1996).

Lesson 3: Focus early program development on a few key strategic priorities and avoid activities—even if worthy—that require more program resources than are available in the initial stages of program development.

While certificate and international programs in sustainability launched in 2003–04 were not successful (the former due to budget issues, the latter because sustainability research and educational capacity at PSU was still emergent when the partnership with Tongiji University was launched), several important capacity building activities were conducted during those same years that helped form a broader foundation of sustainability scholarship. These activities—four of which are described below—were guided by some of the core sustainability concepts referenced previously, such as involving a range of hard and soft science disciplines, promoting problem-based scholarship, adaptive management, and involving relevant stakeholders.

The first effort, focused on social sustainability, was initiated by a small group of faculty and students who felt that PSU's sustainability agenda was overly dominated by the environmental and economic dimensions without sufficient attention to social sustainability aspects such as equity and diversity. With the CASP's encouragement, this group received support from the Vice Provost for Research and Graduate Studies for two course releases and a graduate research assistant to develop one or more new interdisciplinary courses on social sustainability and to develop and submit interdisciplinary grant proposals. The group—which came to be known as the Social Sustainability Colloquium—has maintained solid participation from 20 to 25 faculty, students and community partners in their regular seminars, has created an interdisciplinary team-taught social sustainability course, and helped foster the publication of several scholarly volumes on social sustainability (Dillard et al. 2009; Dujon et al. 2015). This effort has helped elevate this often-neglected aspect of sustainability at PSU and has helped the university develop a truly integrated "triple bottom line" approach to the subject.

The second effort, focused on curricular development, was initiated by a cross-campus faculty group who felt PSU should offer an integrated core of graduate courses in sustainability theory and methods to students in all fields; this effort reflected a concern that the scattered curricular offerings available at the time did not cover all salient sustainability and principles topics in a rigorous fashion. During 2003–04, a subgroup of faculty deliberated on the structure and content of a curriculum to remedy this deficiency and proposed the creation of a 'Graduate Certificate in Sustainability' that would include three core courses on the environmental, social, and economic dimensions of sustainability, and a fourth core course that integrated all aspects into a systems-approach problem-solving exercise.

The third activity, the book group described briefly in a previous section, involved a group of faculty, graduate students and staff that met regularly in the student-operated, sustainability-oriented cafe to discuss popular and scientific writings on sustainability topics. Informal feedback from participants suggested this was one of the most intellectually invigorating forums on campus, helping to build the credibility and reputation of sustainability scholarship on campus.

The fourth initiative, a strategic planning effort, grew out of a sense that, despite the inventory and other activities described above, PSU's academic and operational sustainability efforts were not guided by a clear vision. PSU hired a professional facilitator in early 2005 to help better articulate PSU's sustainability mission by bringing together approximately 40 faculty, administrators, staff, students and community partners to deliberate PSU's desired role in advancing sustainability scholarship and practice.

Lesson 4: Having a neutral facilitator to guide strategic conversations, identify promising ideas and cull the non-productive notions is a valuable investment; the neutrality of the position allows faculty to focus on areas of common interest rather that on defending disciplinary or other turf.

Based on the workshop discussion, a "Declaration of Support for Sustainability at Portland State University" was crafted to provide a concise statement of consensus values that should underpin sustainability scholarship and practice at PSU. Four critical actions were defined to guide program development:

1. Infuse sustainability into all colleges, schools and programs.
2. Develop a sustainable physical campus that is an example to other institutions.
3. Make PSU a living laboratory and demonstration model for sustainable processes and practices, e.g., sustainable food procurement contracts.
4. Develop core multidisciplinary research competencies in key sustainability areas, e.g., green building.

The document was endorsed unanimously by the student senate, while, as one might expect, the faculty senate engaged in a vigorous discussion of the need for such an action. Eventually, the faculty senate endorsed the Declaration by a 70–

30 % margin, helping to further legitimize sustainability research and education as part of PSU's core academic programs.

Lesson 5: Using core concepts from sustainability science—involving a range of natural and social science disciplines, promoting problem-based scholarship, adaptive management, and involving relevant stakeholders—helped assure that each new research, education and outreach activity advanced the institution's base of sustainability scholarship.

The conversations that took place as part of the strategic planning process made it clear that the scholarly agenda surrounding sustainability must explicate and analyze the roles of values and ethics in creating more sustainable development—a central proposition in moving toward transdisciplinary science (Max-Neef 2005). It is important to note that engaging in dialogue about ethics and values does not mean that academic scholars should advocate certain sets of values and ethics over others, in effect giving preference to certain groups in society over others; rather, it means that the resolution of complex problems inevitably involves a host of often conflicting values by affected stakeholders and these need to be made explicit.

Lesson 6: Advancing academic sustainability scholarship requires that the fundamental role of values and ethics be dealt with openly and rigorously.

Using the momentum and ideas from the strategic planning and engagement processes, PSU's vision and mission in sustainability were defined in 2006 as follows:

> PSU Sustainability Vision—To be an internationally recognized university known for excellence in student learning, innovative research, and community engagement that simultaneously advance economic vitality, environmental health, and quality of life.
> PSU Sustainability Mission—To serve as a leading academic laboratory for developing sustainable processes and practices using multi-disciplinary approaches in partnership with business, government, and other organizations.

All of the academic sustainability activities conducted to this point had been supported by relatively small budgets from the Provost and the Vice Provost for Research and Graduate Studies. However, to achieve the vision and mission defined above, more substantial investments in human and physical capital were required; this investment process began with the Provost and Vice Provost for Research providing $100 K of funding in 2005/06 to seed promising areas of sustainability scholarship. An initial request for proposals (RFP) received an overwhelming response from the faculty, indicating a pent up demand for such investments in sustainability scholarship. This early offering solicited research proposals that were interdisciplinary and were focused on outcomes that would advance our understanding of critical sustainability issues.

A second RFP process sponsored by the Center for Sustainable Processes and Practices (CSP2) for awards of up to $10,000 shifted the focus from supporting research to building PSU's capacity in areas that promised to be competitive for extramural support. These early RFPs helped develop criteria for evaluating future investments in sustainability scholarship by PSU faculty that aligned with community interests and PSU's areas of competitive core capacity.

The RFP process and earlier inventory exercises helped define six initial "thrust" areas of interdisciplinary research at PSU: green science and technology development, integrated water resource management, sustainable urban design, sustainable business models, social sustainability, and intelligent urban transportation systems. In addition to the projects supported under the RFPs, CSP2 facilitated the development of several projects that exemplified the university's commitment to interdisciplinary and problem-based approaches and to using the campus and the city as a living laboratory, consistent with the tenets of the Sustainability Declaration. These included a project on eco-roof design and evaluation using one of the campus dormitories as the project site, and a project assessing occupant productivity in green building. Both projects involved University, industry, government, and foundation partnerships.

Lesson 7: The investments of time and resources PSU administration, faculty and students made to develop sustainability priorities in times of scarcity laid a critical foundation that positioned PSU for the investment of significant resources when the opportunity arose.

The Miller Foundation gift of $25 million was announced in September 2008, significantly elevating the level of institutional energy and activity in this area. To date, this is the largest philanthropic gift PSU has received. By structuring the $25 million gift as a ten-year challenge grant, the Miller Foundation intended PSU to use the gift to build institutional capacity and to leverage the gift through additional external funds. The gift stipulated that PSU raise an additional $2.5 million for sustainability programs every year in order to receive the following year's $2.5 million allocation.

Lesson 8: Offering formal and informal opportunities for faculty from different schools and disciplines to meet and share their work is a critical ingredient for interdisciplinary success.

Building on these meetings, a broad RFP was issued in the fall of 2008 for a total of $1.5 million in Miller Foundation funding to ensure that the full range of sustainability activities, expertise and opportunities on campus were identified. The criteria used to guide the RFP built on the principles that had been established in previous years, including an emphasis on interdisciplinary work, community engagement, capacity building efforts, and "catalytic" opportunities that would set the stage for external funding. Although there was a very short timeline for proposal development, almost 100 proposals were submitted in response to the RFP, totaling

over $7 million in funding requests. This was an early signal that while $2.5 million a year represents a significant investment, it was not sufficient to respond to the full range of opportunities to assist sustainability scholarship at PSU.

Projects receiving support addressed a number of themes, with key criteria for funding being capacity building, inter-disciplinary engagement, and leveraging of additional external funds. Funded projects focused on research related to sustainable water management under climate change, ecosystem service changes from dam removal, the establishment of a green building research laboratory, development of a sustainable transportation roadmap, planning and offering a "smart grid" research seminar, sustainable high performance computing, renewable clean petroleum fuels, and support for faculty in the humanities to explore their role in the sustainability arena.

Lesson 9: Bringing focus to sustainability programs so that they reflect the specific assets and character of an institution is essential in order to build competitive capacity; however, the tension between focus and inclusion can be an ongoing challenge.

Providing mechanisms for students to become engaged and to self organize has become an important element of PSU's efforts in recent years, including the hiring of a Student Leadership and Outreach Coordinator based in Enrollment Management and Student Affairs (EMSA) to lead a student-focused Sustainability Leadership Center. The launch of an "Eco-wiki"–primarily designed and managed by students–provided an important communications portal for sustainability related activities; channels for student focused communication have evolved over the years and now include a regular e-newsletter.

Lesson 10: Providing mechanisms for students to engage as fully as possible in sustainability programs leverages one of the core strengths of a university—its students—and allows their ideas to be incorporated into interdisciplinary curricula and research programs.

The Miller gift also helped launch a faculty Fellows program in 2008, initially providing partial salary support for selected faculty to support their sustainability scholarship and to facilitate their campus leadership roles in fostering interdisciplinary research, education and outreach. The role of the Fellows program in providing ongoing guidance and governance for the sustainability programs is still being refined and clarified; a particular challenge has been finding the balance in the roles of Fellows between supporting PSU's broader sustainability efforts and providing resources that advance their own specific research interests.

Lesson 11: Faculty engagement was critical at all stages of PSU's sustainability program development, regardless of whether funds were available to support their efforts; however, investment of financial resources sends an important message about the value of faculty time and effort.

In the fall of 2007 (prior to the Miller Challenge Grant), a seven-member faculty team submitted a pre-proposal to the National Science Foundation's Integrative Graduate Education, Research Traineeship (IGERT) program to establish an interdisciplinary PhD-level program focusing on ecosystem services management that was not supported at that time. Instead, the faculty redirected their efforts through research supported by the Miller Grant Challenge in 2008.

In 2009, the core team, joined by another eight associated faculty members, resubmitted an IGERT pre-proposal. With the benefit of the experience and knowledge gained through the Miller-funded project activities, they were subsequently invited to submit a full proposal by NSF. The proposed program would create four new interdisciplinary courses and use team approaches to problem-based scholarship on ecosystem service challenges in urbanizing areas with twelve local, state and federal community partners. The proposal, entitled "Ecosystem Services for Urbanizing Regions (ESUR)," was selected by NSF for funding in 2010 and awarded $3 million to create a "PhD plus" interdisciplinary training program—the first IGERT awarded to Portland State University. To date, the IGERT has 29 PhD students enrolled with a team of 31 diverse faculty from five colleges who advise, teach or assist the students in conducting interdisciplinary research projects. The success of the IGERT program and of other research initiatives such as PSU's transportation programs illustrate that areas where faculty are already working together or where there is strong faculty leadership provide the strongest base for program enhancement.

Lesson 12: While having financial resources to invest in supporting faculty research can provide useful incentives to engage in collaborative work, such resources cannot substitute for the leadership that must be provided by individual and groups of faculty to build effective collaborative, interdisciplinary programs.

PSU has also learned some lessons about the need to have alignment between program leadership, institutional identity, and programmatic priorities. In 2010 internationally recognized ecological economist Robert Costanza was appointed Director of what was soon renamed the Institute for Sustainable Solutions (ISS). Dr. Costanza's stature brought increased attention to PSU and its sustainability efforts, and his long-standing engagement in ecosystem service research contributed to PSU's profile in this arena.

The importance of having leadership committed to the capacity building intention of the Miller gift became clear during Dr. Costanza's tenure as Director. While having a Director who was a well-recognized scholar brought prominence to the position and the institution, more attention was needed on issues of basic institutional capacity given where PSU was in its development of sustainability programs. Recognizing that these issues were not a priority focus for Dr. Costanza and that a more PSU-centric approach was needed in order to achieve these capacity building goals, co-author and former Associate Director of CSP2 Jennifer Allen became the new leader of ISS in 2011.

Lesson 13: Be true to your institution's identity and candid about its most important needs—"growing your own" leadership can help ensure ownership and alignment with your institution's priorities.

The value of taking a proactive and aggressive approach to communicate about sustainability efforts on campus cannot be understated. Communication was always seen as an important investment, from the engagement of a communications consultant during the 2005 strategic planning process to the investment in strong communications staff at ISS in more recent years. However, given the decentralized structure of universities, the difficulty of getting the attention of busy faculty, staff, students and community partners, and the complex nature of sustainability itself, effective communication is both essential and challenging.

Building capacity across campus while maintaining a clear and identifiable sustainability enterprise also presents a complex set of opportunities and challenges. The Declaration of Support for Sustainability noted above laid out an important guiding principles for the development of sustainability programs at PSU: the opportunity to view it as a campus-wide program and to find ways to harness the assets of the campus toward excellence in this area. These investments, while aligned with the Miller gift's intention to build the institution's capacity, also highlight an ongoing challenge that the Institute for Sustainable Solutions (ISS) has faced: developing and maintaining an identity of its own while serving as a catalyst and steward for programs based in other campus units.

Lesson 14: Clear and ongoing communication about program activities and approaches is particularly important when taking an embedded and distributed approach to sustainability; in addition, maintaining a unit's identity while taking a campus-wide approach can pose ongoing communication challenges.

ISS has moved in recent years toward developing more intentional and sustained partnerships with key community organizations to help provide for more cumulative impact and to create systems that allow for iterative problem solving over time. For example, ISS has partnered with the Bullitt Foundation to invest in support to faculty and staff to work with the City of Portland's Bureau of Planning and Sustainability to identify key research questions related to the city's Climate Action Plan. The ISS has then played a role in identifying faculty whose expertise and interests align with these areas and has brokered a process to further refine research questions and provide support to faculty and students to work on these topics. While PSU has a long standing tradition of community partnerships, this approach differs in the value-add role that ISS plays in supporting the partnership, and in its focus on ongoing dialogue and development of a shared research agenda that can build over time.

This brokering role with the community parallels the role that CSP2/ISS has played within the university over the past decade. Having a unit that can help to build connections and defray some of the transaction costs of doing

interdisciplinary and collaborative work can be a major asset, particularly in institutions like universities, which are organized around multiple disciplines, that have a number of schools or colleges, and that increasingly are organized around performance-based budget models that provide few incentives for collaborative work. However, upper administration must recognize and value that role with ongoing resource commitments for it to flourish.

Lesson 15: Having a unit that can play a brokering role between the community and university as well as across the campus provides a critical infrastructure that can help facilitate deeper and stronger partnerships and champion interdisciplinary and collaborative work.

While progress has been made on interdisciplinary work, challenges remain. ISS hosts the Graduate Certificate in Sustainability described above, which as noted has faced a number of challenges in terms of support for team teaching, ability to respond when additional course sections were needed, and cohesion across the program. In recent years ISS has worked with faculty to design new certificates in focused areas that transcend traditional disciplines, including an undergraduate sustainability certificate and graduate energy and food systems certificates. After a decision by PSU's deans that such programs needed to be hosted within credit-granting units, ISS worked to identify logical homes for these programs that would allow them to maintain an interdisciplinary approach.

ISS also has taken the lead to collect data related to the challenges of doing interdisciplinary work in order provide a more objective basis for exploration of strategies to support such work. A focus group of faculty from a broad set of disciplines indicated both strong interest to engage in interdisciplinary research and teaching and frustration with the institutional structures, such as budgeting that puts primary focus on generation of student credit hours within each college over other forms of academic productivity and performance that make such work challenging.

Work also remains to be done in ensuring that basic sustainability literacy is part of every student's experience at PSU. The Student Sustainability Center in EMSA has helped expand the exposure of students to these concepts, and in 2009 PSU adopted a campus side sustainability learning outcome; however, while the undergraduate University Studies general education program has been very successful in ensuring that community-engaged learning is part of the undergraduate experience, sustainability is not a learning outcome of the program. While the process of developing the undergraduate certificate has helped to better define how the campus-wide learning would translate into measurable indicators and competencies, PSU still lacks a mechanism to ensure that all students are exposed to sustainability concepts. Until PSU adopts sustainability as a core goal of the institution, that exposure will likely remain inadequate. It would certainly seem appropriate that each PSU graduate have meaningful training in sustainability theory and practice given Portland's international leadership role in sustainable development. In doing so, the faculty and administration will likely discover

innovative ways to deliver interdisciplinary education that helps achieve PSU's aspiration of become a leading urban research university.

Lesson 16: Having a unit that can champion collaborative and interdisciplinary work is beneficial, but cannot substitute for broader institutional commitments to advancing these efforts by adopting core values, addressing organizational disincentives and providing of adequate resources.

The trustees of the Portland-based James F. and Marion L. Miller Foundation approached PSU's Provost and senior development staff with a startling opportunity in 2008. The trustees had decided that they wanted to make a ten-year, $25 million contribution to an institution that could have a transformational impact on Portland and the region. The trustees had each independently identified PSU as an institution that they felt had significant potential to lead this type of transformational change. In the course of discussions between the trustees, the Provost and senior development staff, PSU's sustainability programs emerged as the priority area of opportunity for this investment. Factors that contributed to the decision to fund this area were the significant level of campus engagement and institutional groundwork that had been laid for the sustainability programs over the previous years, as well as the strong alignment between PSU's sustainability activities and the priorities and leadership in the broader Portland community.

While the receipt of the Miller Foundation gift raised PSU's sustainability programs and potential to a new level, the most important foundational elements for PSU's efforts were laid when resources were scarce and when faculty had to step out of their comfort zones without financial reward to make things happen. That the Miller Foundation made their gift to the sustainability programs in recognition of the investments of time and energy over the preceding 8 years is a clear validation of these early efforts.

3 Overarching Lessons and Identified Challenges

The development of PSU's sustainability programs described in this paper has been a process of ongoing learning and adaptation toward achieving our long term aspiration to be a national leader in sustainability scholarship. While substantial progress has been made, challenges remain. Overarching lessons from the PSU story include the following:

- It takes time.
- Find and engage champions among faculty and staff (Ostrom 2009).
- Give students responsibility and meaningful roles.
- Top administrative support makes a big difference.
- Engage community partners early and in meaningful ways.
- Demonstrate early success; winners beget more winners.

- Target funding to projects that build core strategic areas of scholarship.
- Choose wicked problems that require the merging of tacit and explicit knowledge.
- Emphasize scholarship aspects to faculty.
- Stress problem solving to the community.
- Seek opportunities for public exposure.
- Bridge the silos.
- Communicate, communicate, communicate.
- Money isn't the only answer.

The lessons that we have highlighted in this chapter reflect our experience and assessment of some of the key considerations other institutions might take into account in building their academic sustainability enterprises. Some of our learning may have applicability and value for other academic institutions, but generalization must proceed cautiously. We recognize that each institution has its own unique culture, context, and characteristics and that sustainability initiatives should take these factors into account in order to ensure that they are aligned with and leverage the institutions key assets and aspirations. Indeed, the process of discovering the best path forward for a college or university should make full use of their experiential knowledge, one of the canons of sustainability theory and practice.

Acknowledgments The information presented in this paper is just a fraction of the work that provides a both broader and deeper discussion of sustainability in the university presented in the book *Sustainable Solutions: "Let Knowledge Serve the City"* (Sheffield: Greenleaf Publishers, 2016), edited by Wortham-Galvin, Allen and Sherman. In addition, to this book, a second volume examines more closely community-university relationships and highlights methods and processes used by PSU faculty in their pursuit of a sustainability agenda—Wortham-Galvin, Allen, Sherman, eds., *Sustainable Solutions: Community-University Relationships* (Sheffield: Greenleaf Publishers, 2016).

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Author Biographies

B.D. Wortham-Galvin, Ph.D. teaches studio, history, and theory of architecture and urban design in the School of Architecture at Portland State University. Her research focuses on how theories of cultural sustainability and the everyday can be applied to the design and stewardship of an adaptable built environment. She is a Faculty Fellow with three PSU institutions: the Center for Public Interest Design, the Institute for Sustainable Solutions, and BUILT (Building Science Lab to Advance Teaching), and she works with local and national communities on issues of equity and resilience in managing change in rural, suburban, and urban places. The *Daily Journal of Commerce* named her one of Oregon's Women of Vision for 2015. She holds degrees from MIT, University of Maryland, University of Pennsylvania, and Brown University.

Jennifer H. Allen, Ph.D. is an associate professor of Public Administration and a Fellow of the Institute for Sustainable Solutions at Portland State University. Her areas of research encompass environmental and natural resource policy and administration, collaborative governance, sustainable economic development, and strategies for incorporating sustainability into higher education. She served as the Director of the Institute for Sustainable Solutions from 2012–2015, where she supported the development of sustainability-related research and curricula across campus and fostered partnerships between PSU and other institutions in the region and beyond. Jennifer has previously worked at the World Bank, Ecotrust, and the Oregon Economic and Community Development Department. She currently serves on the Oregon State Parks and Recreation Commission and on the board of the World Forestry Center. Dr. Allen holds degrees from Yale University, Yale School of Forestry and Environmental Studies, and George Mason University.

David Ervin, Ph.D. is a Professor Emeritus of Environmental Management and Economics and a Senior Fellow in the Institute for Sustainable Solutions at Portland State University. His prior appointments include Professor and Head of Agricultural and Resource Economics at Oregon State University, Professor of Agricultural Economics at the University of Missouri-Columbia, Chief of Resource Policy Branch in the U.S. Department of Agriculture's Economic Research Service, Visiting Scholar at the Office of Technology Assessment, and Director of Policy Studies for the Henry A. Wallace Institute for Alternative Agriculture. He holds BS and MS degrees from The Ohio State University and a Ph.D. from Oregon State University. He has taught courses in environmental economics, economics of sustainability, and business environmental management. His current research areas include ecosystem services and urbanizing regions, business environmental management, and the sustainability of genetically engineered crops.

Jacob Sherman, M.S. Ed. is the Sustainability Curriculum Coordinator for the Institute for Sustainable Solutions at Portland State University. He leads academic and student programs that seek to unleash higher education's ability to address complex problems, including PSU's largest community-engagement program focused on advancing urban sustainability. Jacob previously worked for PSU's award-winning general education program, University Studies, to better integrate student research, engagement, and other creative activities into the undergraduate curriculum. In 2012, Jacob was recognized as both Portland State University's and the State of Oregon's "Student Employee of the Year". He currently serves on the Advisory Committee for the Association of the Advancement of Sustainability in Higher Education (AASHE), the board of the Brentwood-Darlington neighborhood association, and on Portland Bureau of Transportation's Local Transportation Infrastructure Charge committee. He previously served on the PSU Alumni Association and as Board Chair for the Brentwood-Darlington neighborhood association. Jacob holds a Master's Degree in Educational Leadership and Policy, and a Bachelor of Arts in English from Portland State University.

Towards a Smart Campus: Building-User Learning Interaction for Energy Efficiency, the Lisbon Case Study

Ricardo Gomes, Henrique Pombeiro, Carlos Silva, Paulo Carreira, Miguel Carvalho, Gonçalo Almeida, Pedro Domingues and Paulo Ferrão

Abstract

The Smart Campus is a European project based in four pilots located in Helsinki (Metropolia University), Lisbon (Instituto Superior Técnico), Luleå (Technology University) and Milan (Politecnico di Milano), having engaged 76,000 users since August 2012 during 33 months. The main objective of this project was to demonstrate the central role of Information and Communication Technology (ICT) based services that act upon Energy Management Systems and control heating, ventilation and air conditioning (HVAC) and Lighting on achieving energy efficiency through dynamically negotiating building environmental conditions with the users on the University pilots. This paper presents the energy saving results and the best practices obtained in the Lisbon Pilot where ICT equipment was installed in a Library, a lecture Amphitheater and a set of offices. Overall savings were almost 40 % in some test locations. It was observed that energy savings were different between test locations due to particularities such as space typology, occupation and utilization patterns, equipment installed, HVAC and lighting control systems and users interaction.

Keywords

Smart campus · University · Energy savings · Information and communications technology

Several best practices were identified during the testing period of the Smart Campus project on the Lisbon Pilot such as the relevance of planning as soon as possible the

R. Gomes (✉) · H. Pombeiro · C. Silva · P. Carreira · M. Carvalho
G. Almeida · P. Domingues · P. Ferrão
IN+/Instituto Superior Técnico, Av. Prof. Doutor Cavaco Silva,
2744-016 Porto Salvo, Portugal
e-mail: ricardo.a.gomes@ist.utl.pt

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acquisition of the equipment, establishing training sessions with specialized professionals and engaging users using different approaches. It is of outmost importance to perform a frequent review and check control of the energy system control as well as the energy savings obtained. Also several technical problems were identified during the project, namely server malfunctioning, lack of software documentation, unexpected hardware and software bugs and sensors that had to be created from scratch. In what concerns to users behavior it is relevant to highlight that students tend to lose their interest in the project apps along the time.

1 Tackling Energy Efficiency in a University Campus—The Smart Campus Project

Energy efficiency can be defined as "reducing energy or demand requirements without reducing the end-use benefits" (U.S. Department of Health and Human Services 2016). It is one of the most cost-effective methods of enhancing the security of energy supply, and of reducing the emissions of greenhouse gases and other pollutants. Energy efficiency can actually be seen as Europe's largest energy resource (European Commission 2016).

In 2007, the European Council adopted ambitious energy and climate change objectives for 2020 (European Commission 2014), and these included a non-binding 20 % improvement in energy efficiency (European Commission 2010). This specific target was identified as a key factor towards achieving long-term energy and climate goals. Based on an analysis of Member State actions and additional forecasts, the Commission estimated in 2014 that the EU will achieve energy savings of around 18–19 % in 2020. It should be noted that about one third of the progress towards the 2020 target will be due to the lower than expected growth during the financial crisis. It is therefore important to avoid complacency about reaching the 20 % target and avoid underestimating the efforts that will be required in respect of any new target for the period after 2020 (European Parliament 2014).

Because buildings account for about 40 % of the energy end-use in the EU, making buildings more energy efficient is crucial for achieving the abovementioned target (European Commission 2009). Another relevant fact is that publicly owned or occupied buildings represent about 12 % (by area) of the EU building stock (Smart Campus 2015a, b, c, d).

Within this context, the Smart Campus project aimed at increasing energy efficiency in public university buildings (by reducing unnecessary consumption) through a dynamic approach that involves negotiating the building environmental conditions (e.g., temperature, lighting, and ventilation) with the users. With the proposed dynamic approach, the Smart Campus project aimed at transforming the behaviour of university campus users towards more energy efficient practices.

The Smart Campus project aimed at the development of services and applications supported by a data-gathering platform that integrated real-time information systems and intelligent energy management systems. This integration drove a bidirectional learning process so both the user and the building learned how to interact with each other in a more energy efficient way (Smart Campus 2015a, b, c, d). The project explored the potential of innovative Information and Communication Technology (ICT) services acting on building Intelligent Energy Management Systems (IEMS) which control HVAC (heating, ventilation and air conditioning), lighting and other appliances at pilot buildings, thereby working towards a more efficient energy use through a reduction in consumption and dynamically adjusting building environment conditions (e.g. temperature and lighting) in accordance with the building users preferences (Woodal 2011; Manilal and Carreira 2014; Bonino et al. 2012).

Smart Campus was deployed on four pilots where these services and applications were implemented. These pilots are located at the Helsinki Metropolia University of Applied Sciences (Helsinki, Finland); Instituto Superior Técnico (Lisbon, Portugal); Luleå University of Technology—Centre for Distance Spanning Technology (Luleå, Sweden); and the Politecnico de Milano (Milan, Italy). Different services and applications planned in the project are dispersed among the pilots, where some are specifically tested considering the distinctive geographical conditions of each pilot. Within these pilots, energy efficiency efforts are put in practice through different areas and applications, namely lighting, HVAC, and other power appliances, all of which are intensive energy consumers. They are also considered in different contexts, such as classrooms, offices, laboratories, kitchens and corridors.

The services and applications implemented in the project are employed based on a set of best practices for energy usage, learning from the users and their preferences, and adapting default definitions with users' preferences, thus enabling a bidirectional learning process (Vassileva et al. 2012).

This paper focuses on the Lisbon Pilot, namely the methodological approach used, the energy saving results, the best practices and the major problems identified (Fig. 1).

2 Lisbon Pilot

The Lisbon Pilot is located on the Taguspark campus of Instituto Superior Técnico (IST), in the council of Oeiras, about 20 km from the center of Lisbon and 6 km from the sea. The campus was finished in 2009 and has an area of 30,000 m^2, composed by one building with classrooms, offices, laboratories, one canteen and two cafeterias. The campus is owned by IST under the Ministry of Education and Science of the Portuguese Government.

Given the fact that the IST/Taguspark building was built in 2009, it is fairly recent and already incorporates equipment (such as lighting) that is highly efficient and does not require significant structural change. Nevertheless, some problems

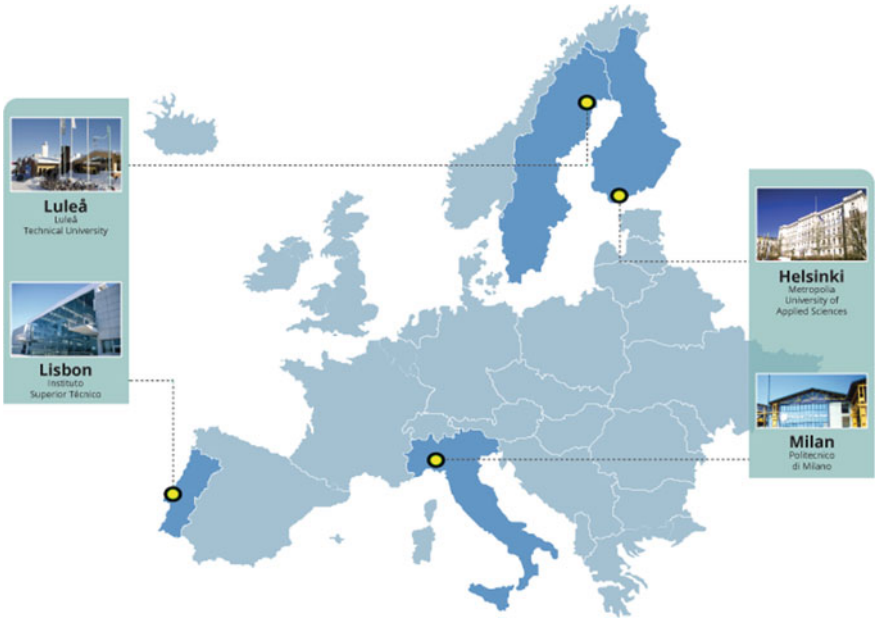

Fig. 1 Smart campus pilots

related with low energy efficiency users' behaviors in some specific test location were found.

The IST/Taguspark pilot developed and implemented an ICT based IEMS that was able to interact with campus users fostering energy efficiency in the test locations of the campus, namely:

- Library (Fig. 2);
- Set of offices—2N14 (Fig. 3);
- Lecture amphitheater (amphitheater A4) (Fig. 3).

Table 1 presents the test locations of Lisbon Pilot, as well as its problems and opportunities.

3 Pilot General Goals

The main and general objectives for the Lisbon pilot test period were:

- Identify the best practices for energy savings
- Calculate energy savings and identify savings resulting from user behavior transformation

Fig. 2 Taguspark interior view and library

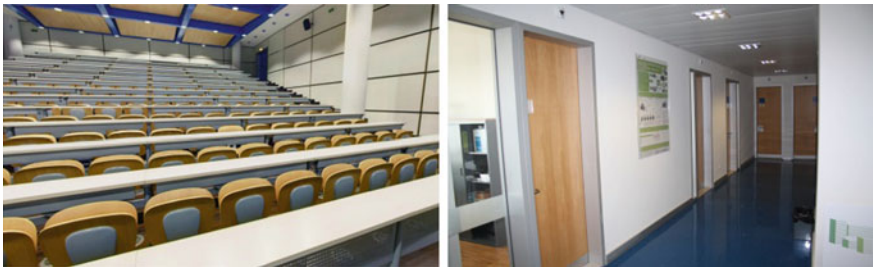

Fig. 3 Amphitheatre 4 and offices 2N14 corridor

- Identify problems found and present ways to solve them
- Identify improvements referring equipment installation and energy management
- Prove the advantages of the Service Oriented Architecture (SOA) as a mean to develop apps to control energy management systems
- Identify the Lessons Learned referring equipment installation, equipment control programming and energy management

4 Methodological Approach

The technological approach used in this project had as main goal to build an abstraction layer over the different hardware and software installed in the test locations that allows to consider different applications to control and manage lighting, HVAC and other equipment in a more energy efficient way.

Table 1 Test locations and identified problems in IST campus

Test location	Description/opportunities
Library	The library has windows facing West, and on the East side it has an enormous interior glass wall that allows daylight to enter from the glass rooftop. At the floor level its capacity is around 50 people. The library is open 24 h, 7 days/week. Lighting and HVAC systems are usually working. Intelligent lighting systems can improve the overall lighting usage having in consideration both outside and interior lighting conditions
Offices 14 (2N.14)	Group of offices on the second floor with 13 rooms/Manual control of HVAC and lighting are not effective. Permanent lighting of the corridors is not suitable to its usage (circulation areas)
Amphitheatre A4	Interior amphitheater (without windows) with around one hundred seats, used for lectures/Difficult access the lighting switchboard. Adapting the lighting settings of the room to their class is something that not all the teachers are aware of as it requires switching off manually the board. The HVAC set point is not suitable to the classroom users

The implementation of the Lisbon Pilot considered distinct technologies on the hardware and software levels that were integrated in a Service Oriented Architecture (SOA). The hardware level architecture considers KNX, CAN, Lon/Schneider and Modbus fieldbus technologies. Each group of devices uses a specific fieldbus and connects to the IP network through a gateway module. Each space is monitored and controlled using one of the fieldbus technologies and the same middleware software is used to communicate with either of these technologies.

The SOA makes it possible to add new technologies by adding new services to the middleware layer. The IEMS service layer connects to the middleware services exposing all the devices and information, unaware of the heterogeneity and complexity of the devices.

The Lisbon Pilot uses the KNX protocol in 2N.14 to control and read from a large variety of devices, such as: lights, HVAC systems, motion sensors, temperature and humidity sensors, etc.

The HVAC system in A4 room is controlled with Lon/Schneider devices via an OPC server, acting as a gateway between the middleware and the Lon network.

Finally, the iLight protocol is used to control the luminaries in the Library, using a vendor specific API.

Figure 4 presents the schematic of the SOA architecture considered in this project.

5 Service Oriented Architecture

The Smart Campus project relies heavily on a strong ICT infrastructure as a means to realize energy savings and to effectively engage users. The project envisions an IEMS backed up by an appropriate SOA which, among other advanced

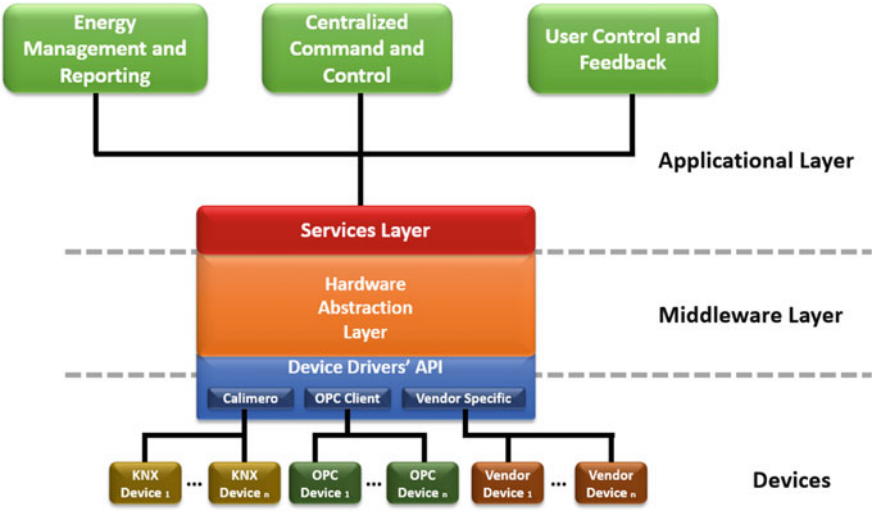

Fig. 4 Proposed architecture for the Lisbon pilot (Smart Campus 2014a, b, c)

applications, delivers energy management and equipment control functionalities. Such IEMS is also capable of tracking individual occupant preferences, distinct locations and equipment characteristics into managing energy costs (Smart Campus 2014a, b, c).

6 Implementations at Test Locations

The equipment implementation at the test locations can be divided in two stages. In the first stage the energy meters that measure the electricity of each test location were installed. Also, two control groups were defined to help determined energy savings from corrective measures: another set of offices, 2N.16, is the control space of 2N.14, and another lecture amphitheater, A5, is the control space of A4. The installation of the energy meters finished in December 2013 in each pilot test location and in the control locations (Smart Campus 2014a, b, c) (Fig. 5).

The second stage considered the technical solutions of the IEMS that were installed in the test locations in March 2014. In the following 2–3 months to the IEMS were considered taking into account users' feedback, installation errors correction and upgrade of new contents or interfaces. During the equipment implementation, the mockup applications previously created allowed the consideration of users' feedback and by that improving the IEMS interface (Smart Campus 2015a, b, c, d), contributing to the effectiveness of the energy saving scenarios proposed (example on Fig. 6). The Table 2 depicts the Lisbon Pilot technical solutions that were considered in each test location.

Fig. 5 Energy meters of INOV installed in the electric panel

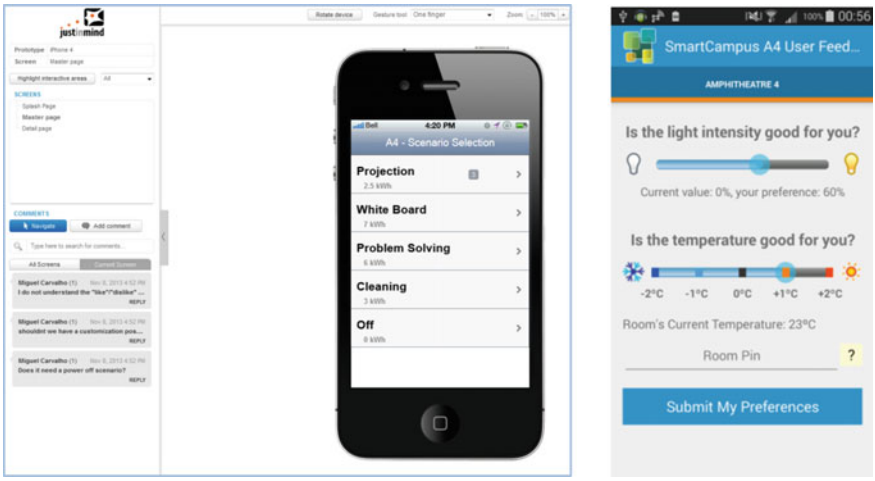

Fig. 6 Screenshot of the mockup app (*left*) and of the mobile app developed for the Amphitheater users (*right*)

In the following figure one example of one mockup and one mobile app developed within the Smart Campus project are presented.

7 Co-creation

Two different aspects of Living Lab Methodology were considered in the Lisbon pilot implementation plan, namely the consideration of different competencies to stimulate knowledge sharing between the Smart Campus team (environment,

Table 2 Pilot applications at IST Taguspark pilot

Space	Application	Target	User involved	Technical solution
Library	Smart automatic control of lighting conditions	Improving lighting efficiency	Staff	Daylight sensors
	Control of the HVAC and lighting level	Improving user comfort	Students	Web app that interacts with the IEMS
Amphitheatre A4	Automatic scenario management for lighting and video projector	Improving teaching conditions and energy usage optimization (lighting and projector)	Teacher	Web app that interacts with the IEMS
	Cooperative HVAC setting	Improving HVAC operation/efficiency	Student and Teacher	Web app to achieve cooperative HVAC setting, incorporating user preferences, room occupancy, temperature sensors
Offices 14 (2N.14)	Smart management of HVAC and lighting systems	Improving users comfort in the offices and reducing energy losses	–	Web app incorporating user temperature preferences and room occupancy
	Efficient lighting of the corridors	Improving lighting energy efficiency	–	Lighting timer. Motion sensors

informatics, engineering, sociologist and others) and the understanding of the involved stakeholders' visions.

To promote users' engagement as defined in a co-creation process, the IST team developed several methodologies (Smart Campus 2014a, b, c):

- Internal workshops were taken with students, technical staff, decisions makers, and experts from different areas namely engineering, environment and energy management.
- Surveys to identify the perception of the energy consumption of the stakeholders at the university were performed on more than one hundred people.
- Development of mockups for the web and mobile applications developed within the IEMS to integrate user's feedback.
- 2N.14 office staff commented the control apps developed within the Smart Campus project, proposing improvements and validating their functionalities and operating.

- Several master students participated and worked on the elaboration of different system control and dashboard apps.
- Several meetings were done with specialists from the control systems providers in order to better understand the system control software
- Feedback from teachers, professors and the energy manager of the Taguspark were taken into account when improving the control apps. The feedback was normally related with aspects that could improve the lectures and the users comfort.

8 Test Methodology for Energy Savings

The expected energy (electricity) savings are calculated considering the baseline equation defined for each test location and the measured energy consumption. The baseline equation returns the energy consumption expected for each test location based on historical data prior to the deployment of the project, thus describing the expected energy that should be consumed without the intervention of the project.

$$\begin{aligned} \textit{Electricity savings} = {} & \textit{Baseline electricity consumption} \\ & - \textit{Measured electricity constumption} \end{aligned}$$

As previously mentioned control groups were also defined for the offices (2N.14) and Amphitheatre (A4). These groups helped confirming the energy savings calculations.

9 Baseline Consumptions Estimation

The energy savings across the different spaces were calculated considering the methodology defined in the International Performance Measurement and Verification Protocol (IPMVP) (International Performance Measurement and Verification Protocol 2002). The calculations were undertaken with previous consumption recordings (2013) to train the model and then test it against data that is recorded after implementing of energy efficiency measures.

The baseline equations were improved during the test period. For the energy savings calculation for the test locations the baseline equations were (Smart Campus 2014a, b, c):

- **A4:**

$$Electricity\_cons = 23.1 \times Occup + 7.3 \times DL - 76.0$$

- **Library:**

$$Electricity\_cons = 37.3 \times Occup - 200.2 \times DL + 0.792 \times SR - 13.0 \times RH + 4742.0$$

- **2N.14:**

$$Electricity\_cons = 6.7 \times Occup - 8.62 \times DL + 209.5$$

where

Electricity_cons	*electricity consumption*
Occup	*space occupation* (*occupants/h*)
DL	*Day length* (*h/day*)
SR	*Solar radiation* [W/m^2]
HR	*Average Relative humidity* (%)

10 Experimental Location A—2N.14 Offices

The 2N.14 is a space where the main users are researchers, administrative staff and PhD students. The most significant consumptions are related to HVAC and lighting. Therefore, it was decided to tackle these systems though a smart management strategy that takes into account user preferences and also outside and interior temperature conditions, as well as office occupation.

Master and PhD students developed self-learning adaptive control algorithms that operate upon the energy control system installed in offices. These algorithms were then implemented through an online user-interface that is accessible by the office staff through their PC, where they can control the HVAC system. Through an interaction between the control system and the users, it was possible to define an efficient way to provide a comfort-working environment personalized for each user preferences.

Other energy efficiency measure defined in this space was the intelligent control of the lighting system in the corridors, where the light only turns on when someone walks in the corridor.

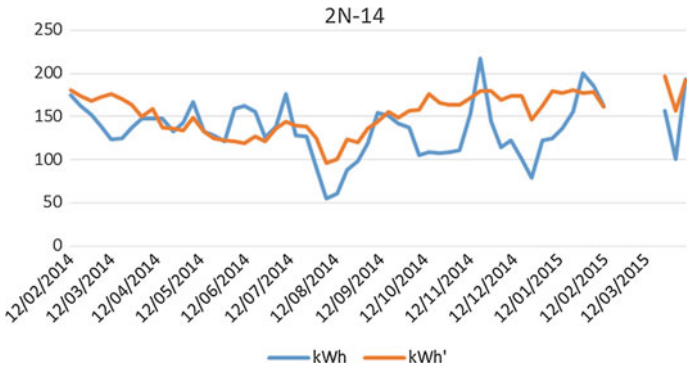

Fig. 7 Real Energy consumption and baseline energy consumption values for 2N.14 (Smart Campus 2015a, b, c, d) (*blue line* real energy consumptions; *orange line* baseline consumption. A gap occurred on February 2015 due to meters malfunction)

11 2N.14 Offices Results

The energy consumption results for one year of the test period of the nucleus 14 are presented next (Fig. 7).

The overall energy savings for the 2N.14 are of 12 %. This value can be improved in the future, considering the implementation of better control algorithms that are being studied and analyzed by PhD students.

12 Experimental Location B—A4 Amphitheater

In order to enhance energy efficiency in this space, a set of scenarios that control lighting and video projector were defined. Also, a cooperative setting of the lighting and indoor temperature was conceived. The students can express their comfort preferences related with lighting and temperature levels through a mobile app developed within the Smart Campus project.

13 A4 Amphitheater Results

The energy consumption results for one year of the test period of the A4 are presented next (Fig. 8).

The overall energy savings for the Amphitheater 4 are of 3.5 %.

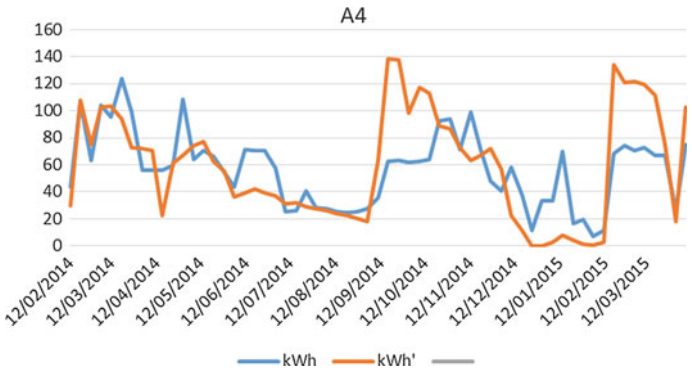

Fig. 8 Real energy consumption and baseline energy consumption values for the Amphitheater 4 (Smart Campus 2015a, b, c, d) (*blue line* real energy consumptions; *orange line* baseline consumption)

14 Location C—Library

In the Library, solutions were proposed for reducing HVAC and lighting energy consumption.

The smart automatic control of lighting based on lighting glaring from the exterior conditions and users' preferences, was defined considering lighting sensors data and the lighting dimming solutions installed.

Also, in this space the students can express their temperature and lighting preferences using a mobile app developed within the Smart Campus project.

15 Library Results

The energy consumption results for one year of the test period of the Library are presented next (Fig. 9).

The overall energy savings for the Library are 42 %, which is a significant achievement.

16 Replicability of the Smart Campus Project

The achievements quantified in this project are a result of a well-documented methodology on the deliverables of the Smart Campus project. In particular, the functionalities installed in the library, namely the dimming control and daylight harvesting capability, are suitable for libraries with different spaces, architecture

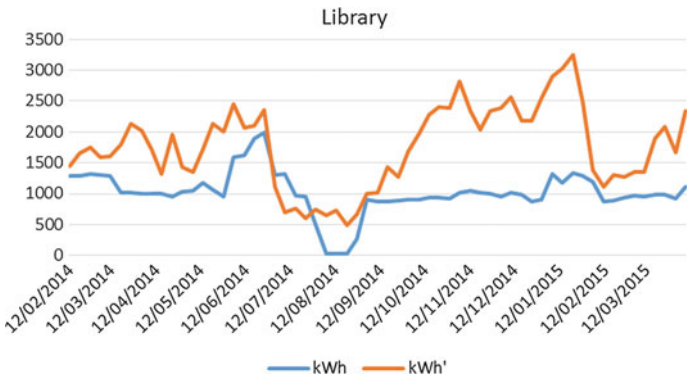

Fig. 9 Real energy consumption and baseline energy consumption values for the library (Smart Campus 2015a, b, c, d) (*blue line* real energy consumptions; *orange line* baseline consumption)

and occupation. Therefore, the energy savings obtained in the Library are replicable to similar spaces within the European Union universities and public buildings.

The strategies defined for controlling lighting and HVAC control installed in the offices are also suitable for similar spaces (with individual offices) where users can express their preferences in terms of lighting and temperature.

17 Recommended Best Practices

Several best practices were identified during the testing period of the Smart Campus project on the Lisbon Pilot (Smart Campus 2015a, b, c, d). The most relevant are here highlighted:

- It is important to plan as soon as possible the acquisition of the equipment especially when tendering processes are involved.
- Training sessions with specialized professional and technical meetings are crucial points to develop applications and interfaces to control the energy systems installed
- Engaging users is very important to enhance energy savings and this should be done using different approaches, such as web contents, brochures, K-lines and other exposition material in the test locations and workshops.
- It is of outmost importance to perform a frequent review and check control of the energy system control as well as the energy savings obtained.

18 Lessons Learned

The most relevant problems during the Smart Campus project are here identified (Smart Campus 2015a, b, c, d):

- Problems with the server occasionally resulted in loss of energy consumption. Nevertheless, the company that installed the energy meters provided the service of data backup.
- Lack of documentation of the different software installed required an extra effort to programming the equipment control and the need to create drivers.
- Due to safety reasons it was necessary to define a VPN (with and independent PC associated) to the energy manager of the building, situation that add difficulties to the programming and the equipment control.
- The hardware and software installed for lighting and HVAC control had frequent bugs that were not expected and this was an obstacle for the programming.
- Some sensors were created from scratch since the companies that provided the other hardware did not commercialize this type of equipment and existing ones from other fabricants had compatibility issues.
- The students give more attention to the apps when they are presented at the beginning, losing their interest along the time.

19 Pilot Summary

The Lisbon Pilot experience can be summarized as very positive. The main goal of the project was achieved, since several applications that enhance energy savings and changing behaviors towards a more energy efficient ones, were defined and executed over a platform provided by the Service Oriented Architecture developed in the Smart Campus project. The applications vary from mobile apps that control the HVAC and lighting systems, considering the comfort levels by interacting with the occupants, to different types of dashboards that show energy savings and consumption in real time.

The achieved energy savings results in each test location were different in percentage due to particularities of the test locations such as space typology, occupation patterns, utilization patterns, equipment installed, HVAC and lighting control systems.

It is relevant to say that in some test locations the payback period for the equipment installed is high. Nevertheless, it was possible to infer that new algorithms for energy system control that consider users' feedback are being developed and could significantly improve energy savings. Lastly, the faculty benefits from this project with equipment and conditions for the development of new apps and to

improve the interaction between students and the building, in a more energy efficient way.

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Author Biographies

Ricardo Gomes is a PhD student at MIT Portugal—Sustainable Energy Systems program and his research area is related with building energy simulation and energy consumption estimation. Ricardo worked in different energy efficiency areas since he finished in 2006 his Environmental

engineering graduation at Universidade Nova de Lisboa. From his working background it can be highlighted his experience on an ONG, on a HVAC and building energy certification company and in the Portuguese National Laboratory for Civil Engineering. At Instituto Superior Técnico, Ricardo worked on the coordination of the Lisbon Pilot of the Smart Campus project.

Henrique Pombeiro is a Portuguese visiting researcher at MIT, being granted by the Fulbright, MIT Portugal and KIC InnnoEnergy PhD Programs. Henrique is doing his PhD in Sustainable Energy Systems, focusing his research under energy efficiency in buildings, developing a framework to define the best practices and user engagement strategies for better efficiency, at the same time he is developing energy models that can more effectively describe how energy is used in buildings. Henrique is also a co-founding member and COO of a startup company, Watt-IS, now with 7 full time employees, where he is managing the development of a platform to engage end users on more efficient behaviors.

Carlos A. Santos Silva is an Invited Associate Professor in Engineering Systems, holder of the WS Energia Chair, at Instituto Superior Técnico (IST), Technical University of Lisbon. Born in Lisbon in 1976, he holds a degree (1999), a MSc (2001) and a PhD (2005) in Mechanical Engineering from IST. From March 2001 until February 2004, he was a junior researcher at Siemens AG, Corporate Technology Information and Communications, Neuro-Informatics Department (Siemens CT-IC4), in Munich, Germany. From February 2004 until January 2007, he returned to Portugal to work as lecturer at Escola Náutica Infante D. Henrique (ENIDH), Department of Maritime Engines, Automation and Control Systems area. From July 2006 until May 2008, he joined Albatroz Engineering Inc. as a Project Manager, an Information Technologies start-up company. Since June 2008, he joined the MIT Portugal Program at IST, where he was the coordination deputy of the PhD and Advanced Training Programs in Sustainable Energy Systems of the MIT Portugal Program and since 2012 in the PhD in Renewables from European Institute of Technology (EIT)—KIC Innonergy PhD School. Since October 2012, he holds the WS-Energia Chair. He is also the principal investigator in several industrial and research projects in the area of energy planning and energy efficiency.

Paulo Carreira is a lecturer of Software Engineering and Database Systems subjects in the Department of Computer Science and Engineering of IST. In recent years he became interested in the role of Computer Science to create energetically efficient buildings. He is the organizer of the IT4ENERGY international workshop on Information Technology for Energy Applications. Before joining academia he worked 10 years in industry in different projects and was the head of development of Data Fusion, a tool set for large-scale data integration and migration used in the banking industry. While working in industry he managed to complete a Masters and PhD in Computer Science and Engineering from the University of Lisbon.

Miguel Carvalho is a BSc in Computer Sciences at IST, an MSc in Engineering Policy and Management of Technology from IST and a MBA in AESE/IESE Business School. He has 9 years of experience in the management of multidisciplinary teams and the development of new renewable energy projects in Spain, UK, Poland and Cyprus. From 2009 to 2015 he was the Executive Director of the MIT Portugal Program.

Gonçalo Almeida studies at Instituto Superior Técnico (IST), concluding his MSc degree in Telecommunications and Informatics Engineering. Gonçalo has been practical working experience with multiple technologies during his academic course. These technologies range from embedded development and mobile development to databases and web frameworks. Gonçalo is an advocate for Agile development and Scrum, and has been practicing these skills for several years.

Pedro Domingues studied at Instituto Superior Técnico (IST), where he concluded his MSc degree in Computer Engineering, specializing in the fields of Robotics and Embedded Systems, covering hot-topics such as Cyber-Physical Systems and Building Energy Efficiency and the development of scalable Building Automation software. During his academic course, Pedro actively participated in several group activities such as the *Programa Mentorado*. Pedro also worked in the Institute of Mechanical Engineering at IST (IDMEC/IST), where he modeled and simulated stochastic systems.

Paulo Ferrão was born in Lisboa in 1962, graduated in Mechanical Engineering in 1985 at IST—Instituto Superior Tecnico of the Technical University of Lisbon, where he obtained the prize for the best student of the year in his field. He obtained a Master in Heat Transfer and Conversion in 1998 and a PhD and in Mechanical Engineering at IST in 1993 and 2004, respectively. He concluded a graduation in Strategic Management in the Context of Innovation at ISCTE in 1988. He is the National Director of the MIT-Portugal Program, the major international partnership on Science and Technology in Portugal, in the field of Engineering Systems, and he is also the focus area lead for Sustainable Energy Systems. He is Full Professor at IST. He is co-founder of IN+, Center for Innovation, Technology and Policy Research and he is coordinator of the area of Sustainable Technologies and Environmental Systems at the Institute for Systems and Robotics—associated laboratory (ISR).

He is author of three books and co-author of two other in the area of Industrial Ecology, its principles, tools and different case studies. He is author of more than seventy papers published in journals and book chapters and over eighty papers presented in conferences and invited talks in different domains. He has co-organized more than a dozen international conferences and leaded more than thirty scientific projects in the areas of Energy Efficiency and Industrial Ecology.

Addressing Food Waste Through University and Community Partnerships

Petra Molthan-Hill, Helen Puntha, Aldilla Dharmasasmita, Kirsty Hunter and Beverley Lawe

Abstract

The sustainability of local and global food systems is a significant challenge with far-reaching implications for all. The purpose of this paper, which addresses the specific issue of food waste, is to offer replicable practices from five different projects which aimed to reduce or reuse food waste. These were partnership projects between university staff, students and local organisations to facilitate extra-curricular student activity, support students' sustainability literacy, and to contribute towards creating sustainable communities. Projects included a 'Super Kitchen', where food destined for waste was used to create nutritious meals, a

P. Molthan-Hill (✉)
Nottingham Business School, Nottingham Trent University,
Burton Street, Nottingham NG1 4BU, UK
e-mail: petra.molthan-hill@ntu.ac.uk

H. Puntha
Centre for Academic Development and Quality—202 Dryden Centre,
Nottingham Trent University, Burton Street, Nottingham NG1 4BU, UK
e-mail: helen.puntha@ntu.ac.uk

A. Dharmasasmita
Green Academy, Nottingham Trent University, Burton Street,
Nottingham NG1 4BU, UK
e-mail: aldilla.dharmasasmita@ntu.ac.uk

K. Hunter
School of Science and Technology, Nottingham Trent University,
Burton Street, Nottingham NG1 4BU, UK
e-mail: kirsty.hunter@ntu.ac.uk

B. Lawe
School of Education, Nottingham Trent University,
Burton Street, Nottingham NG1 4BU, UK
e-mail: beverley.lawe@ntu.ac.uk

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'Feeding the 5000' event in partnership with a local Council and three other projects. The paper details findings from the project evaluations to explore student participation rates, motivation, and student awareness of food waste issues as well as reflections on the most effective aspects of project design for student appeal. The projects themselves contributed to the reduction of local food waste and the majority of participants reported that the projects transformed their perceptions of food waste. The paper may be of interest to academics and researchers interested in student perceptions of sustainability and of particular interest to those looking to establish their own sustainability-themed partnership projects.

Keywords
Students · Food waste · Volunteering · Partnership · Community · Extra-curricular · Sustainable development · Project design · ESD

1 Introduction: Food, Sustainability and Higher Education Institutions

The United Nations Environment Programme calculates that globally approximately one third—or 1.3 billion tonnes—of the food produced for human consumption gets lost or wasted each year.[1] In the UK, recent research indicates a 15 % reduction in household food waste between 2007 and 2012, however a huge volume of food—with an estimated value of £12.5 billion—is still wasted every year (Quested et al. 2012); much of this waste could be avoided or the food itself eaten with more effective management.

Gustavsson et al. (2011: V) argue that 'while we as consumers have no control over food lost in production, we do have some control over the food which is wasted thereafter'. The Food and Agriculture Organisation of the United Nations (FAO) corroborate this, describing wasted food as a 'missed opportunity' to 'mitigate environmental impacts' (FAO 2013: 6).

A study by Williams et al. (2012)—including student households—found money was by far the most important motivator to reduce food waste, congruent with other studies which found that sustainability considerations are not direct motivations for reducing food waste (Graham-Rowe et al. 2014). Research into how Higher Education Institutions (HEIs) themselves might address food waste within their sphere of influence is limited. Two notable studies are Whitehair et al. (2013) who explored student food waste on campus and Sarjahani et al. (2009) who examined variance in food and other compostable waste in all-you-can-eat university dining facilities.

[1] http://www.unep.org/wed/2013/quickfacts/ (Accessed 18 February 2016)

In addition to how HEIs might address food waste in a practical sense, there is the question of how food sustainability is addressed within education. Many studies have illustrated a tendency of HEIs to teach sustainability within the narrow confines of single disciplines; this may be unhelpful as sustainability challenges are complex and tend to cross disciplinary boundaries (Barth et al. 2007; Littledyke et al. 2013). Food sustainability is an example of such a cross-disciplinary issue and extra-curricular activity may therefore prove a useful outlet for education and awareness-raising (Sterling 2013). Barth et al. (2007: 428) argue that student engagement in volunteering and other extra-curricular projects, 'enlarges the learning space and facilitates better learning opportunities for developing future-oriented competencies across different contexts'.

Community engagement may be key to learning enhancement. In recent years, HEIs have increasingly tried to engage communities as active participants to address sustainability issues (Kuhtz 2007) and research has demonstrated that community-based learning can enhance student attainment of sustainability learning outcomes (Shephard 2008; Clifford and Petrescu 2012).

Baldwin and Chung (2007) discovered that individual values carry power in an institutional setting, and similarly, that individual values can be affected by University culture as experienced by some participants. This finding is echoed in studies by Savageau (2013) and Allen-Gil et al. (2005) which both found that reflexivity is important in transforming student perspectives regarding food waste.

Drawing upon such knowledge from the sector on the most effective ways of educating and empowering students with regard to sustainability, Nottingham Trent University (NTU) designed five community partnership projects on the subject of food waste. Designing a number of different projects at once enabled a trial of different project models; encouraged a wider pool of participants, including community, with various preferences; and contributed in a more holistic way to awareness of food waste issues within preparation, consumption, retail etc. This paper will outline each project, provide details of the evaluation approach and discuss the findings before presenting some conclusions. In providing both evaluation findings and project details it is hoped that the paper will provide inspiration for institutions to design their own partnership projects and also give an insight into how students experience and gain from such projects; currently an under-researched topic within the literature.

2 Project Descriptions

The five projects described here, designed in partnership with community members and organisations, aimed to facilitate students' sustainability literacy and support the creation of sustainable communities. The projects incorporate elements of volunteering, collaboration, extra-curricular inter-disciplinary learning, and reflexivity as guided by the literature.

All projects were affiliated with or coordinated by NTU 'Food For Thought'; a cross-institution initiative led by the NTU Green Academy, a Higher Education Academy (HEA) scheme.[2] The initiative uses food as a unifying theme for staff and students to learn about sustainability and contribute to global challenges of food production and consumption through curriculum and extra-curricular activity (Puntha et al. 2015).

2.1 'Super Kitchen on Campus'—Pilot Study

The Super Kitchen social enterprise, which began in 2013, uses food that is edible but would otherwise go to landfill to create cheap, healthy food in popup kitchens (Anon 2015). There are currently 11 Super Kitchens in Nottinghamshire, serving an estimated 22,000 meals to date. Super Kitchen has three main aims: to reduce food waste, implement social eating schemes, and encourage healthy food consumption.

It follows that the student population could benefit from access to Super Kitchens as they may experience social isolation and poor dietary habits (Deliens et al. 2014). In light of this, the Super Kitchen model was piloted at NTU with the aim of introducing a socially, economically, and environmentally sustainable model of eating to educate students about food systems and encourage healthy eating. The project was a joint initiative between BSc (Hons) Exercise, Nutrition and Health Course Leader Dr Kirsty Hunter, Green Academy, and Super Kitchen Founder Marsha Smith.

The pilot was undertaken by three undergraduate students during their final year research project and supervised by Dr Hunter. The students ran three events for student athletes on Wednesday afternoons-NTU sport afternoon-in the Student Union Building. During these events, participants were served freshly cooked food and surveyed about their perceptions and knowledge of food waste.

Ingredients were supplied by FareShare, a national charity organisation which obtains edible but surplus or close to use-by/best-before date foods from supermarkets, and redistributes this to charities including breakfast clubs, women's refuges and senior citizen lunch clubs (Fareshare n.d.). Based on available ingredients, the research students devised meals appropriate for student athletes i.e. low fat, low sugar, one or more portions of fruit or vegetables along with complex carbohydrates and protein. Meals were typically three courses and included vegetarian options. Ingredients were unknown until collection point. Additional ingredients were ordered online. The meals were prepared by the students in the campus Nutrition Suite and were free for participants.

Collaboration continues with students now undertaking sandwich year placements with the Super Kitchen team. The relationship is mutually beneficial: students gain experience of volunteering, research, working and learning from guest lectures by Marsha Smith, as well as opportunities to apply theories of sustainability

[2] https://www.heacademy.ac.uk/sites/default/files/resources/Green%20Academy%20programme%20compendium.pdf (Accessed February 18, 2016)

and community health promotion in a real world context. The Super Kitchen team gains enthusiastic volunteers to help generate an evidence base and bring Super Kitchen projects to new locations.

2.2 'Feeding the 5000 and Vegetable Varsity Events'

In 2014, Nottingham City Council (NCC) ran a high-profile food waste prevention project, Feeding the 5000 (Kim 2014), a collaboration between the national 'Love Food Hate Waste'[3] campaign, Super Kitchen, Fareshare, WRAP,[4] Advice Nottingham, Nourish Associates, and linking in with the 'Feeding the 5000' organisation, Feedback Global.[5] All are nationwide charities with a common objective: to change attitudes towards and reduce food waste at every level through collaboration between governments, businesses, international institutions, NGOs. The Green Academy team viewed the event as an opportunity to spearhead HEIs to participate in such campaigns.

The key purpose was to organise a free dining event for the public using food destined for waste. Feedback Global has successfully organised similar 'Feeding the 5000' events in Trafalgar Square (2009 and 2011), Paris, Amsterdam, Dublin, and Bristol. A spin-off was the provision of training opportunities to a range of organisations to develop 'Love Food Hate Waste' Community Champions who, with the Council's support, could spread the message into neighbourhoods, via cooking workshops and awareness events etc.

As part of NTU's contribution to the event, student volunteers were recruited to help at a pre-event food preparation session, marketed as the 'Vegetable Varsity Chopping Competition' with students from neighbouring HEI, the University of Nottingham. The idea was twofold: to provide volunteering opportunities for students already interested in food sustainability, and to make the topic itself more appealing for students.

A planning meeting was hosted by NTU and was an important event in itself as it brought many community figures together to work collaboratively on a common-interest issue. The Vegetable Varsity event was held on NTU campus, using produce provided by afore-mentioned Fareshare and attended by 17 students from University of Nottingham and 13 from NTU as well as representatives from Notts TV. The students chopped all the vegetables, which were cooked the following morning into 4680 free meals (vegan curry) for the Nottingham public.

[3] http://www.lovefoodhatewaste.com/ (Accessed February 18, 2016)

[4] http://www.wrap.org.uk (Accessed February 18, 2016)

[5] http://feedbackglobal.org (Accessed February 18, 2016)

2.3 'Love Food Hate Waste' Cascade Training

As a result of links forged with 'Love Food Hate Waste' through the 'Feeding the 5000' event, a 'Love Food Hate Waste Cascade Training' was initiated for NTU staff and students. Sessions explored participants' own habits, and how to effectively cascade messages about food waste to others, using both environmental (extrinsic) motivations and financial (intrinsic) motivations for reducing food waste in order to appeal to those already engaged with the sustainability agenda, as well as those looking for practical tips of how to reduce impact and save money. The session included personal waste reduction strategies, information about UK food waste policy, and implications for the retail sector. Partnership Advisor from Charity WRAP, Marion Homer, ran the training sessions. WRAP work with the UK Government, the EU, and others to help deliver policies on waste prevention and resource efficiency.[6]

The event was heavily advertised but, unfortunately, not well attended by students, this is discussed later. The number of NTU staff who attended was more encouraging.

2.4 FoodShare

FoodShare is a collaborative project between NTU, UPP (a student-accommodation organisation), NTSU, and local charity Nourish Associates Ltd. who initiated the project (Nettleford 2014). FoodShare is a social food growing space on what was a bare plot of campus land where student and staff volunteers can grow their own food and attend free 'Climate Friendly Gardening' training. Initially, the pilot project ran as a weekly 3 hour session for ten weeks. Due to its success, the project is now in its third term, with 35 regular student gardening volunteers.

Volunteers learn how to build and maintain raised beds and polytunnels, water produce using harvested rain water, sow produce seeds and harvest produce once ready[7]. The fresh, seasonal and pesticide-free food grown is split 50/50 between growers themselves and local Nottingham charity, Emmanuel House, supporting homeless, vulnerable or isolated people within the community[8]. This arrangement helps to address food shortages for communities that need them most, and reduce food miles and packaging (Fig. 1).

[6] http://www.wrap.org.uk/content/about-us (Accessed February 18, 2016)

[7] http://www.trentstudents.org/volunteering-opportunities/foodshare-growing-to-give-climate-friendly-gardening–3/apply_for_opportunity (Accessed February 18, 2016)

[8] http://www.emmanuelhouse.org.uk/site/ (Accessed February 18, 2016)

Fig. 1 Student volunteers helping out at the Foodshare allotment

2.5 Student Cooking Classes

'Let's Get Cooking' (LGC) was founded in 2007 with lottery funding to set up UK school cooking clubs where pupils could prepare and enjoy healthy food, sometimes with parents. The clubs work with wider community and target mainly inner-city and areas of social deprivation.[9] Beverley Lawe, a Senior Lecturer in the Secondary Education Team, School of Education at NTU approached LGC with the idea of having an NTU-based LGC club in 2010. Using funding from the School of Education, LGC provided training and branding.

NTU students have since been encouraged to both lead and participate in cooking classes, which have focused mainly on encouraging students to eat healthily (Lawe 2013) and adopt sustainable living practices such as using seasonal produce and minimising waste. Research by Campbell-Arvai (2015) indicated a student preference for actions such as recycling and food waste reduction over avoiding processed foods or reducing meat consumption.

Classes run every academic year offering extra-curricular opportunities for students to meet new people and learn valuable cooking and food preparation skills. Each session has a theme generated by the original group of students, and a wide range of recipes; students cook one recipe and taste the others then take away all recipes to use again. Recipes are also available for all students on the NTU virtual

[9]http://www.letsgetcooking.org.uk/ (Accessed February 18, 2016)

Fig. 2 A 'Let's Get cooking' session

learning platform, known as NOW. The sessions build on each other, gradually increasing participants' confidence.

An essential part of the classes is that they are run for students by students. Students invited to lead were from an Education and Nutrition background; offering them valuable teaching/training experience to support their chosen careers.

To date, 115 students have participated in classes and 35 students have been trained as trainers. Feedback has been very positive e.g. 'Eating something is good, but cooking something good is much better; I always enjoy the cooking classes, it is really useful'. Lawe (2013) reported that in 2011, 89 % of attendees rated the sessions as excellent/good and all had enjoyed the sessions, 84 % thought their skills had improved and 75 % felt more confident about cooking after the course. Almost 70 % indicated that they were likely to continue to eat more healthily after the course. Students delivering sessions commented, 'fantastic concept', 'improving our communication and organisation skills', and receiving 'feedback on doing a good job' (Fig. 2).

3 Evaluation Approach and Findings

Projects were evaluated via two versions of a questionnaire. One questionnaire was designed specifically for Super Kitchen as it needed to address certain topics relating to the students' course requirements and a second was used for the

remaining four projects and contained some of the same questions as the Super Kitchen questionnaire. As projects were all hosted under the banner of 'Green Academy', the multiple case design enabled analysis of the initiative as a whole as well as of the individual projects. A case study approach was appropriate as there was no need to control certain events or variables but to simply study them (Yin 2013) albeit in the spirit of action research i.e. with a view to making future improvements to projects.

3.1 'Super Kitchen' Pilot Study

Immediately after their meal, Super Kitchen attendees completed a semi-structured questionnaire devised by the project students in collaboration with their supervisor. The questionnaire contained 14 questions covering the following areas:

1. The sensory quality of the meals (5 questions)—taste, appearance, and portion size.
2. Participants' interest in attending future Super Kitchen events (5 questions)—preferred days/times and dishes and suggested cost per meal.
3. Participants' perceptions of food waste (4 questions)—levels of concern, types of food wasted and whether perceptions changed following their Super Kitchen meals.

All 95 participants (100 %) completed the questionnaire. Thematic analysis was undertaken for qualitative data and key descriptive statistics were generated. Key findings are summarised in Table 1.

Table 1 Keys findings from the super kitchen on campus pilot study (n = 95 participants)

Question	Percentage of respondents
Would you like a super kitchen event every wednesday after sports matches?	Yes—98 % No—2 %
Would you attend a Super Kitchen event at other times during the week? When?	Yes—86 % No—14 % Early evenings—40 % Lunchtimes—36 %
Were you satisfied with your meal?	Yes—99 % No—1 %
How much would you be prepared to pay for a super kitchen meal	£3—29 % £2—45 % £1—26 %
Are you concerned about food waste?	Yes—60 % No—40 %
Has your perception of food waste changed as a result of the super kitchen meal?	Yes—40 % No—32 % Unsure—28 %

One of the key aims of the pilot was to determine consumer demand for a regular campus Super Kitchen; results were very encouraging as can be seen in the table. There was a 99 % meal satisfaction rate, suggesting the researchers were successful in creating dishes that had sensory appeal.

An initiative such as Super Kitchen would need to be financially self-sufficient in order to be sustainable. 74 % of participants were willing to pay £2–3 charge per meal which is the typical charge at other Super Kitchens in Nottingham and the higher price option given in the questionnaire, indicating that participants valued the food on offer, and reinforcing customer demand for a regular Super Kitchen. These prices are considerably cheaper than the alternative hot meal options available to students on campus.

When questioned about food waste, 60 % (n = 57) of participants were concerned about food waste and the most common foods thrown away were fruit & vegetables (47 % of participants named these as the foods that they threw away the most) in line with the findings of WRAP (Quested et al. 2012). Forty percent of participants felt that their perception of food waste had changed as a result of the event, 32 % felt it had not and 28 % were unsure.

3.2 FoodShare, 'Feeding the 5000', 'Love Food Hate Waste' Cascade Training and the Student Cooking Classes

A questionnaire based on the 'Super Kitchen' questionnaire and with some additional foci was designed to evaluate the other four projects. Additional content explored students' perceptions and behaviour, and the impact of project design on student participation. The resulting questionnaire contained 10 questions and addressed:

1) Qualities of the project impacting on student participation (2 questions)
2) Participant perceptions and behavioural change towards food waste following events (5 questions).
3) Demographics (3 questions)

The questionnaire was disseminated to all student participants via web-based platform Survey Monkey, benefits of the web platform being ease of administration and student access by students of different campuses. 16 responses were received; the lower response rate being attributed to the online format and perhaps also due to the gap in time between project end and questionnaire distribution, e.g. the 'Vegetable Varsity' took place in October 2014, but the questionnaire was distributed in March 2015.

In more detail, 63 % of respondents were student cooking class participants (10), 18 % (3) each were from the 'Feeding the 5000' event and the 'FoodShare' project, and 1 % (2) were from the 'Love Food Hate Waste' Cascade Training event. One of the focus areas was to explore student motivations for participation. 63 % stated that gaining skills to help solve sustainability challenges (in this case food waste)

was the key reason for participating, followed closely (50 %) by wanting to gain transferable skills (e.g. communication, interpersonal, time management). Concern about food waste and wanting to meet new people was the third most common reason for participating (38 %).

When questioned about feature(s) of a good project, 'to gain skills that are not taught in lectures/seminars' was the most cited response (83 %), closely followed by 'learning something not related to their degree/course of study' (75 %).

In terms of student perceptions towards food waste, 66.7 % of respondents stated that they are no longer indifferent to food waste, 41.7 % are now more conscious of food waste when cooking, and 33.3 % are both more aware that food waste is an issue that needs addressing and said that they have learnt more about food waste than they initially anticipated.

4 Discussion

The projects were initiated by community stakeholders or were otherwise based on existing models from outside NTU. In all cases NTU staff extended original project goals and incorporated additional design features for student appeal. In the case of the 'Feeding the 5000' event initiated by Nottingham Council for example, staff added the element of competition by creating the Vegetable Varsity event. Interestingly, none of the questionnaire respondents rated the competitive element as important; more important especially for first year students, was meeting new people. All projects contained an element of collaborative activity whether chopping vegetables, learning to cook, planting vegetables or learning about food waste.

According to questionnaire findings, students were looking for an experience beyond the classroom; the 'Love Food Hate Waste' Cascade Training might have evoked associations with 'normal' curriculum. A possible explanation for the success of the 'Super Kitchen' Pilot Project could be the appeal of convenient free food following a sports event, however the questionnaire responses indicate that students would be willing to pay for such an offer on a regular basis. The Pilot ran smoothly due to the collaborative efforts of staff and students from the Sport Academic Department, Green Academy, Department of Sport and Lifestyle, the Student Union, FareShare and local Super Kitchen members. Buy-in from the undergraduate students who ran the study was created by incorporating it into curriculum, as part of their final year research project.

The aspect of social eating within Super Kitchen could be beneficial since having a strong social network reduces the risk of developing a mental health issue (Ohayon and Roberts 2014) and increases the likelihood of recovery from one. There are some groups, therefore, who may benefit particularly from attending regular events, for example new and international students. The 'Let's get cooking classes' and 'FoodShare' project could bring similar benefits. The 'Love Food Hate Waste' Cascade Training in its current design is a one-off event; redesign might benefit from focussing on increasing elements of personal contact and group

activity. The notion of group learning has arisen in other Food for Thought initiatives not reported here such as the Sustainability in Practice certificate, a flexible online course open to all NTU students and staff (Molthan-Hill et al. 2016): student participants who would usually complete the certificate individually specifically requested ad hoc 'Sustainability Challenge' days incorporating volunteering and collaborative group learning to complement the individual online course as they felt that this would support greater learning gains and personal meaning.

Students leading the cooking sessions gain the additional benefits of confidence and skills which they can then take out into the wider community. As the main university campus is based in the city of Nottingham where there are many local projects designed to help families feed themselves better and the East Midlands has significant foodbank use[10] it may be possible to link with groups using the Super Kitchen model to offer on or off-campus cooking classes to secondary school pupils and families who want to improve their skills and make the most of economical ingredients.

Most respondents reported that events had changed their perception of food waste; this might be reflected in their actual behaviour, and could be investigated further with a research project aligned to Super Kitchen that includes a more overt educational aspect. In the future, feedback will be sought directly after each event and also a few months afterwards to explore longer term impacts.

5 Conclusions

Evaluation findings indicate in line with literature, that students valued practical action over information transmission. In addition, they valued the social nature of projects and enjoyed the collaborative rather than competitive elements of projects. Most respondents reported that their perceptions of food waste had been altered; further research would need to be undertaken to discern whether this carried through into their behaviour.

There are limitations to the evidence presented here. Both participation rates and questionnaire response rates varied greatly between projects. Questionnaire data cannot necessarily be generalised to the wider population. Super Kitchen respondents for example were all athletes and 95 % were male; not a representative sample of the university population and previous research indicates a difference between eating-related perception and behaviours of male and female students (Driskell et al. 2006).

Super Kitchen will certainly continue with the next step to create an infrastructure for routine events; perhaps through a Super Kitchen Social Enterprise run by sandwich placement students and volunteers with supervision from NTU staff. Logistics of this scale up will include procuring physical resources for storing and serving food, a permanent event venue, and financial investment for resources plus

[10] https://www.trusselltrust.org/news-and-blog/latest-stats/ (Accessed March 4, 2016)

other initial outlays such as crockery and cutlery. In addition, routine delivery of food by FareShare to campus will be introduced. It is felt that the roll out of the Super Kitchen model at NTU will provide a vehicle with which to educate students about food waste and sustainability. Providing information for diners to read and creating an NTU Super Kitchen website, for example, would help spread awareness of how to reduce food waste.

FoodShare is continuing as presented here but has been also linked to the aforementioned Sustainability in Practice Challenge Day. The combination of FoodShare practical work, online teaching and personal contact proved popular, with the first event fully booked within four hours of its announcement. Feedback from the first three challenge days has been very positive.

Overall, projects contributed to reducing food waste by using waste ingredients ('Super Kitchen' and 'Feeding the 5000'), raising student awareness of food sustainability issues (all projects) and by teaching students how to cook from scratch ('Let's get cooking'). The latter may have contributed to reducing packaging waste through enabling student participants to cook fresh rather than packaged food. The collaboration with different organisations has proved successful and further joint projects will be undertaken in the future.

Our vision is that other universities will be encouraged by this paper to develop similar projects on and around their campuses so that together, we can jointly contribute to the reduction in global food waste.

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Authors Biography

Dr. Petra Molthan-Hill is leading the HEA Green Academy 'Food for Thought' Project for Nottingham Trent University. The aim of the project is to develop curricular and extra-curricular activities embedding sustainability into various disciplines, from Business Studies through Medieval History to Astrophysics, including the Sustainability in Practice Certificate that was shortlisted for the Green Gown Awards 2014. Petra is also Sustainability Coordinator and a researcher at Nottingham Business School. Recently, Petra has won the Guardian University Award 2015 in Business Partnership for her Greenhouse Gas Management Project, an innovative project for the core curriculum.

Helen Puntha is Deputy Lead for the HEA Green Academy 'Food for Thought' Project for Nottingham Trent University. She completed a Masters on the effectiveness of breastfeeding support services and has a continuing interest in nutrition, health and wellbeing, viewing these as vital aspects of sustainability work. As a Research Officer for the University Centre for Academic Development and Quality, she also works in the areas of active learning and assessment and feedback. She coordinates an undergraduate research scheme.

Aldilla Dharmasasmita is the Academic Associate for the Green Academy at Nottingham Trent University. She manages the Sustainability in Practice Certificate, a project shortlisted for The Green Gown Award 2014. She is also an Associate Lecturer with Nottingham Business School (NBS) specialising in Business Ethics, and is part of a team that oversees students' projects with businesses in addressing their GHG emissions, a project which won the Guardian University Award in Business Partnership in 2015. She completed her Masters in Corporate Social Responsibility after being awarded a full-tuition scholarship at The University of Nottingham. She is currently a PhD candidate with NBS researching Education for Sustainable Development (ESD) skills.

Dr Kirsty Hunter is a senior lecturer in Nutrition in the School of Science and Technology at NTU. She is Course Leader of the BSc (Hons) Exercise, Nutrition and Health and delivers nutrition, metabolism and health lectures at under- and postgraduate level within the department of Sport Science. She has integrated food sustainability into the BSc (Hons) Exercise, Nutrition and Health through collaboration with the universities Green Academy and local initiatives such as Super Kitchen. Kirsty is currently working with colleagues to bring the Super Kitchen model of sustainable eating to NTU using a Social Enterprise run by students.

Beverley Lawe is a senior lecturer in the School of Education at NTU where she teaches on both undergraduate and postgraduate initial teacher education. Her main work is with students who want to teach Design and Technology in secondary schools; her specialism being food technology. Beverley also contributes to other courses at NTU, including primary education and nutrition modules in sports science. Before training teachers Beverley was a teacher herself for 26 years in a variety of schools holding different posts. Beverley is also a trainer for food safety and delivers this as a freelance. Beverley is an active member of the Sustainability Action Forum at NTU and has set up cookery classes to encourage healthy sustainable eating for students and staff from any part of the university.

Does "Science" Matter to Sustainability in Higher Education? The Role of Millennial College Students' Attitudes Toward Science in Sustainable Consumption

Jiyun Kang, Gwendolyn Hustvedt and Stefanie Ramirez

Abstract

Higher education has committed to fostering the development of students as educated consumers as well as ethical professionals capable of valuing sustainability in their decision-making. Making decisions based upon the understanding of the complexities of sustainability requires a certain level of scientific knowledge and appreciation that can be introduced and developed by educators. However there has been no empirical study that supports significant relationships between attitudes toward science and sustainable consumption to date. This study developed a model depicting the effects of attitudes toward science on beliefs about sustainability and attitudes and behavioral intentions toward sustainable consumption. The model was tested via structural equation modeling with online survey data collected from 1,480 millennial college students in the Southern US. The results suggest that perceived importance of public understanding of science directly affects beliefs about sustainability including ethical obligation, consumer effectiveness, consumer responsibility, and perceived knowledge, which in turn indirectly affects attitudes and behavioral intentions toward sustainable consumption. An interest in science as a career, however, does not demonstrate such effects. This study is vital to higher education, policy makers, and industry practitioners who are working on turning consumption towards sustainability and expanding their ability to provide the scientific foundation that students can use to make sustainable decisions.

J. Kang (✉) · G. Hustvedt · S. Ramirez
School of Family and Consumer Sciences, Texas State University,
601 University Drive, San Marcos, TX 78666, USA
e-mail: jkang@txstate.edu

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Attitudes toward science · Sustainable consumption · Millennial · STEM · Sustainability

1 Introduction

Sustainability in higher education becomes more important than ever, and the efforts to strengthen sustainability at universities include conducting relevant research, incorporating sustainability in the curriculum, and concurrently developing sustainable activities on campus to reinforce the principles presented in a classroom (Collins and Gannon 2014; Morrissey and Závodská 2014; Wooltorton et al. 2015). Such efforts in higher education can foster the development of students as educated consumers and ethical professionals capable of valuing sustainability in future professional decision-making (Biedenweg et al. 2013; Everett 2008). Making sustainable decisions in daily consumption as well as those impacting future business dynamics requires scientific knowledge and appreciation about complexities of the environmental, social, and ethical aspects of sustainability (Adomßent et al. 2014). Scientific concepts can be introduced to students at various levels and across higher education curriculum (Correia et al. 2010), and the importance of scientific understanding and interest in science can be triggered by educators and administrators on campus as well as the surrounding community and businesses that serve or hire students. However, there is a gap in the literature when it comes to research on changes in sustainable consumer behavior among students that can be connected to their education, including among students who are not personally interested in the scientific education that underlies much of sustainability education.

A simple definition of sustainability could be the combination of scientific knowledge with ethical decision making. The term was developed after the confrontation between the industrialized world, acting on scientifically based environmental concerns, and the developing world, acting on prosperity concerns that environmental decision-making needed to include ethical recognition of "the rights of the human family to a healthy and productive environment" (Report of the World Commission on Environment and Development 1987). Without underlying scientific advances, society cannot make sustainable innovations (Aricò 2014; Holbrook 2009). Increasingly, businesses are committing to transparency and investing in program and materials development to communicate the science behind sustainability via sharing research findings, project updates, and case studies with young consumers (Innovation Center for U.S. Dairy 2015). These efforts are intended to enable the next generation of consumers, including the Millennial generation (born 1980–2000) to develop scientific understanding and make informed, sustainable choices and accurate decisions. Businesses that fail to understand even the basic science behind the production of their products, face the risk of lawsuits for false

claims, such as by the Federal Trade Commission (FTC) against retailers mislabeling rayon (Federal Trade Commission 2013).

Efforts to communicate relevant scientific details about sustainability would be worthwhile with empirical evidence supporting significant relationships between Millennials' attitudes toward science and their beliefs, perceptions and behaviors of sustainable consumption.

Millennials' perceptions and behaviors related to sustainable consumption have been examined (Hume 2010; Norum 2013; Smith and Brower 2015), however, there has been no attempt that empirically examines the effects of their attitudes toward science on sustainable consumption. To fill this remaining gap in the literature, this study sheds light on how Millennial college students' attitudes toward science affect perceptions and beliefs regarding environmental, societal, and ethical issues related to sustainability, and in turn, how these perceptions and beliefs affect sustainable consumption. We focus on Millennials because of their significance to society as the largest generational cohort in the United States with unique characteristics distinguishable from other populations (Pew Research Center 2010). We specifically examine Millennial college students, as they are in the critical life stage in which they form their beliefs and attitudes while in formal educational settings (Barton et al. 2014; Richard and Oblinger 2003). These beliefs and attitudes would last over their entire lives as consumers in marketplaces as well as decision-makers in the professional world. Educators and business practitioners can foster this generation in building positive attitudes toward sustainability and their willingness to act more ethically and socially responsibly, which, because of the cohort's size, would make a significant difference on the environment and society.

2 Millennials and Sustainable Consumption

Howe and Strauss (2000) categorized Millennials as born in 1982 through 2004. Statistically, Millennials are ethnically and racially diverse, less religious, immersed in technology, and forecasted to be the most educated American generation (Howe and Strauss 2000; Pew Research Center 2010; Wolburg and Pokrywczynski 2001). Additionally, they are characterized by social, cultural, and environmental consciousness (Sheahan 2005). These distinct attributes set them apart and establish differentiating consumption characteristics.

Hanks et al. (2008) conducted a study on the attitudes toward sustainability relating to materialistic consumption of Millennials and found a counter-culture exists within this cohort fitting a globally collective grouping described as caring about sustainability (p. 340). Studies found Millennials to be sensitive to issues of sustainability (Maggioni et al. 2013), committed to the consumption of certain sustainable goods (e.g., Pomarici and Vecchio 2014), yet with an attitude-behavior gap requiring further research to understand and reveal explanations for this discrepancy (Maggioni et al. 2013).

3 Attitudes Toward Science and Sustainable Consumption

While Millennials may be introduced to sustainability in a variety of high school and college coursework, the science, technology, engineering and math (STEM) fields at many universities have begun to make a more concerted effort to introduce the environmental aspect of sustainability (Klotz et al. 2014; Weber et al. 2014). Research in sustainability education suggests students need at least a basic understanding of scientific concepts that underlie natural systems (Eike et al. 2014).

Although there has been no attempt to explore attitudes toward sciences within consumer behavior, more specifically the sustainable consumption context, attitudes toward sciences have been extensively examined in the education field. Those studies have used a large variety of measures, typically created for a single study and not used again (Blalock et al. 2008). One measure, the Science Attitude Index (SAI) developed by Moore and Sutman (1970), has been used (directly or adapted) in numerous studies. The SAI has been revised (Moore and Foy 1997) and contains 40 items grouped into six domains. Two of the domains are especially appropriate for exploring how the emphasis of scientific understanding and science education impacts Millennials' behavior. For this study, we chose to use the SAI that measures these two major domains of attitude toward science—*interest in science* and (perceived importance of) *public understanding of science*. The items measuring public understanding of science have been used previously in studies such as Feist's (2012) to capture the concept that science and scientists benefit society. The items measuring interest in science focus specifically on interest in a career in science, which have been used in studies such as Sorge et al. (2000), a study of Hispanic students exploring the impact of attending STEM events on science-related career intentions. Ma-Kellams and Blascovich (2013) suggested beliefs related to science create an increase in moral decision-making. They conceptualized and measured moral behaviors using an experimental approach where participants were asked to variously; judge the extent of sexual exploitation in a short story about date rape, choose to split the money between themselves and other participants or choose for pro-social activities such as blood donation over distractor behaviors such as seeing a movie. Results showed the 18–28-year-old participants' "belief in science" positively related to increased condemnation of date rape and an increased likelihood to donate to charity, volunteer or give blood. Additionally, an increased "belief in science" predicted giving more money to others. Ma-Kellams and Blascovich (2013) introduced a possible connection between exposure to the philosophical approach represented by science and ethical behavior that was intriguing and worth examining in the context of sustainability as related to consumer behavior.

Previous research has also shown a personal sense of ethical obligation is strongly related to behavioral intention in ethical and sustainable consumption (Raats et al. 1995; Shaw et al. 2000; Sparks and Shepard 2002). Mayo (2005) points out consumers might feel they need a degree in environmental science to "know what exactly you should or should not be doing" (p. 18). Research on the connection between science-based knowledge and consumer behavior has taken place

for decades, and generally finds an indirect connection between science-based knowledge about the environment and specific ethical consumer behaviors (Kaiser et al. 1999). The relationship between science-based beliefs about the environment and behaviors such as recycling newspaper (Ellen et al. 1991) or purchasing organic cotton (Hustvedt and Dickson 2009) are typically mediated by variables such as perceived consumer effectiveness or ethical obligation. For this reason, we can hypothesize SAI-measured attitudes toward science would likely be connected to sustainable consumption behavior of Millennials through the mediation of variables of our interest. Accordingly, the following hypotheses were developed:

H1. Interest in science directly affects (a) ethical obligation, (b) personal consumer effectiveness, (c) consumer responsibility, and (d) perceived knowledge.
H2. Interest in science indirectly affects (a) attitude toward and (b) behavioral intention toward sustainable consumption.
H3. Public understanding of science directly affects (a) ethical obligation, (b) personal consumer effectiveness, (c) consumer responsibility, and (d) perceived knowledge.
H4. Public understanding of science indirectly affects (a) attitude toward and (b) behavioral intention toward sustainable consumption.

4 Ethical Obligation and Sustainable Consumption

Ethical obligation refers to the internalized ethical rules of an individual reflecting personal beliefs on what is considered appropriate behavior (Shaw et al. 2000). Consumers consistently maintain their desire to make a difference through consumption and see relevance of personal values to ethical purchasing (Bray et al. 2011). Addressing ethical obligations concerning sustainable consumption aids in identifying characteristics regarding concerns and purchase behaviors. Millennials appear sympathetic to ethical issues (Gorman et al. 2004) and boycott brands that violate environmental or social norms. They believe in ethical responsibility to make the world a better place, internalize that responsibility and support that attitude through action (McGlone et al. 2011), and believe companies should do the same (Lancaster and Stillman 2002). Research has shown ethical obligation serves as a casual antecedent to attitude and behavioral intention (Raats et al. 1995; Shaw and Shiu 2002b; Sparks et al. 1995). Therefore, the following hypothesis was developed:

H5. Millennial college students' ethical obligation significantly affects their (a) attitude toward and (b) behavioral intention toward sustainable consumption.

5 Personal Consumer Effectiveness and Sustainable Consumption

Millennials account for purchasing power with significant current and future impact as the most powerful consumer group in the marketplace (Farris et al. 2002). Financial power can have direct implications and contributions with regard to sustainable consumption via their perceived effectiveness. How an individual feels about their ability to influence an issue is known as *perceived consumer effectiveness* (Roberts 1996). Those who believe they have the ability to impact the environment are more likely to behave sustainably, as they believe their perceptions can convert into action (Verma 2002). Willingness to engage in responsible behavior occurs if consumers feel they have more impact on environmental improvement (Straughan and Roberts 1999). Thus, the following hypothesis was developed:

H6. Millennial college students' personal consumer effectiveness significantly affects their (a) attitude toward and (b) behavioral intention toward sustainable consumption.

6 Consumer Responsibility and Sustainable Consumption

Consumer responsibility is the notion consumers can affect and bear some responsibility for environmental impacts (Jansson et al. 2010). While responsibility for increased carbon footprints can be shared by industry and consumers (Lenzen et al. 2007), this demonstrates a need for understanding consumer responsibility in relation to environmentalism and sustainable consumption among Millennials. Schwartz (1968, 1977) proposed behavior is driven by awareness of consequences and feelings of responsibility for carrying out a specific behavior. Research has shown a relationship between consumers' sense of responsibility and consumption behavior (Wells et al. 2010). The consumer responsibility Millennials feel toward environmental and social problems could be driven by awareness and sense of responsibility thus affecting attitude and ultimate consumption behavior. Therefore, the following hypothesis was developed:

H7. Millennial college students' consumer responsibility significantly affects their (a) attitude toward and (b) behavioral intention toward sustainable consumption.

7 Perceived Knowledge and Sustainable Consumption

Perceived knowledge, what a person thinks they know, can have significant effects on how specific consumers behave. Takács-Sánta (2007) suggested a barrier to environmental action and concern may be consumers are not receiving information on environmental problems. Barber et al. (2009) found the level of environmental knowledge regarding sustainable products influences consumer's willingness to purchase the sustainable product. Research has indicated lack of knowledge limits consumers' ethical decisions and consumption signifying a need for information (Bray et al. 2011), while increases in knowledge are precursors to concern for the environment (Brosdahl and Carpenter 2010), a more favorable attitude toward sustainable products (D'Souza et al. 2006), and increased sustainable behavior (Chan 1990; Hines et al. 1986/1987; Vining and Ebreo 1990). Therefore, the following hypothesis was developed:

H8. Millennial college students' perceived knowledge significantly affects their (a) attitude toward and (b) behavioral intention toward sustainable consumption.

8 Attitude and Behavioral Intention Toward Sustainable Consumption

It is argued a generational cohorts' specific preferences, beliefs, and psychographic tendencies influence their behaviors (Gursoy et al. 2007). Findings suggested most Millennials hold positive, although varying, attitudinal orientations toward the environment (Smith and Brower 2015). Additionally, attitude-behavioral theories suggest if one holds an extremely positive attitude toward sustainable products it could promote repurchasing activity in the future. This led to developing the following hypothesis:

H9. Millennial college students' attitude toward sustainable consumption significantly affects their behavioral intention toward sustainable consumption.

9 Methodology

An online survey tested the research model and hypotheses for this study. To capture the Millennial generation, we surveyed undergraduate students aged 18–32 at a large university in the Southeastern United States. An email invitation with a link to the survey system was sent to the entire body of undergraduates (N = 29,458), and 1589 completed and valid responses collected in two weeks. Those not in the selected age range were excluded (n = 109). Finally, a total of 1480 responses were only used for the data analyses. Participants ages ranged 18–

32 (*SD* = 2.76), and the median age was 20. Males accounted for 27.4 % of the sample, and females accounted for 72.6 %. Euro-American/American made up 54.5 % of the sample, Hispanic/Latino (a) respondents accounted for 29.4 %, African-American respondents for 6.9 %, Asian respondents for 3.6 %, and other ethnicities accounting for 5.5 %. Freshmen accounted for 23.4 % of the sample, sophomores for 17.6 %, juniors for 24.8 %, and seniors for 34.1 %. The majority of the sample, 92.2 %, was classified as full-time students while 7.2 % was classified as part-time students, and 0.6 % was classified as "other." Part-time working respondents made 46.4 % of the sample while unemployed totaled 44.8 %, and full-time employed being 8.8 % of the respondents. Respondents with an annual household income of under $50,000 made 67 % of the sample, $50,000 to just under $75,000 made 9.7 %, $7500 just under $150,000 made 16.7 %, $150,000 and up made 5.3 %, and unanswered responses made about 1.3 % of the sample.

9.1 Instruments

The survey questionnaire includes measurements for the main constructs for this study. All the measurements were adapted from pre-existing, established scales in the literature in the fields of science education, consumer sciences, and social psychology. *Interest in science* and *public understanding of science* were measured with five and two items, respectively, from the revised SAI scale by Moore and Foy (1997). *Ethical obligation* was measured with an item adapted from Shaw et al.'s study (2000). *Perceived consumer effectiveness* was measured with four items adapted from Roberts' study (1996). *Consumer responsibility* was measured with four items adapted from Jansson et al.'s study (2010). *Perceived knowledge* was measured with two items adapted from Dickson's study (2000). *Attitude toward sustainable consumption* was measured with three items adapted from Chan's study (2001). Lastly, *behavioral intention toward sustainable consumption* was measured with three items from adapted from Chan's study (2001). The completed list of measurement items is shown in Table 1. The reliability and validity of all the measurements were ensured and reported in the following Result section.

9.2 Analysis

In order to test hypotheses, the data was analyzed using structural equation modeling (SEM) following the recommended two-step procedure: measurement model testing and subsequently structural model testing (Anderson and Gerbing 1988). Measurement model testing enables to identify and correct statistical errors of the measurements, by which reliability and validity of the measurements can be ensured. Subsequently, structural model testing is followed in order for examination of linear relations among latent variables of interest, by which hypotheses can be tested.

Table 1 Instruments and final measurement model properties

Constructs	M	SD	CFA Loading	SMC	t value	α	Composite reliability	AVE
Interest in science						0.917	0.887	0.612
IS1 I would like to work with other scientists to solve scientific problems	2.986	1.233	0.877	0.770	–			
IS2 Working in a science laboratory would be fun	3.186	1.240	0.826	0.682	41.185**			
IS3 I would enjoy studying science	3.219	1.261	0.882	0.778	46.471**			
IS4 I would like to be a scientist	2.621	1.273	0.828	0.685	41.391**			
IS5 I may not make great discoveries but working in science would be fun	3.292	1.045	0.740	0.547	34.322**			
Public understanding of science						0.795	0.814	0.687
PUS1 People must understand science because it affects their lives	3.764	0.968	0.757	0.573	–			
PUS2 Every citizen should understand science	3.757	0.930	0.872	0.760	20.527**			
Ethical obligation						–	–	–
EO I feel that I have an ethical obligation to purchase environmentally and socially responsible products	3.396	1.059	–	–	–			
Perceived consumer effectiveness						0.770	0.797	0.663
PCE1 It is worthwhile for the individual consumer to try to do something about pollution or sweatshops	3.981	0.903	0.766	0.586	–			
PCE2 Since one person can have an effect on pollution, natural resource problems, or sweatshop issues, it makes a difference what I do	3.905	0.958	0.819	0.670	24.989**			
Consumer responsibility						0.864	0.852	0.657
CR1 As a consumer, I feel partly responsible for global warming	3.291	1.178	0.759	0.576	–			
CR2 As a consumer, I feel partly responsible for the increase in pollution	3.615	1.026	0.889	0.790	38.244**			
CR3 I am partly responsible for the environmental problems related to increased waste from consumption	3.670	0.978	0.844	0.713	33.572**			

(continued)

Table 1 (continued)

Constructs	M	SD	CFA Loading	SMC	t value	α	Composite reliability	AVE
Perceived knowledge						0.811	0.793	0.660
PK1 I believe that I am informed about environmental and ethical issues	3.230	1.091	0.744	0.554	–			
PK2 I believe I am knowledgeable about sustainability	3.173	1.082	0.917	0.841	15.374**			
Attitude toward sustainable consumption						0.868	0.898	0.746
ASC1 I (1 = dislike to 5 = like) the idea of purchasing sustainable products	4.051	0.894	0.859	0.739	–			
ASC2 Purchasing sustainable products is a (1 = bad to 5 = good) idea	4.245	0.803	0.795	0.632	34.583**			
ASC3 I have a (1 = negative to 5 = positive) attitude toward purchasing a sustainable version	3.949	0.924	0.836	0.699	36.608**			
Behavioral intention toward sustainable consumption						0.912	0.914	0.779
BI1 Over the next three months, I will consider buying products because they are less polluting or more socially responsible	3.682	0.966	0.883	0.781	–			
BI2 Over the next three months, I will consider switching to other brands for environmental or ethical reasons	3.589	1.024	0.914	0.835	49.200**			
BI3 Over the next three months, I plan to switch to a sustainable version of a product	3.436	1.001	0.847	0.718	43.437**			

Note Other than attitude toward sustainable consumption, all items were measured on the 5-point Likert scale from 1 = strongly disagree to 5 = strongly agree

10 Results

10.1 Measurement Model Testing and Results

A measurement model was specified with 21 observed variables for eight latent variables, for which a confirmatory factor analyses with maximum likelihood estimation was performed. Two items from perceived consumer effectiveness and one item from consumer responsibility were excluded due to their low factor loadings (<0.70). The model showed a good model fit to the data: $\chi^2_{(df = 162)} = 413.316$, $p = 0.000$; GFI = 0.973; AGFI = 0.962; CFI = 0.986; NFI = 0.978; RMR = 0.024; RMSEA = 0.032. Given the fit, the reliability and validity of the measurements were examined. Based on Cronbach' alphas, (0.770–0.917), and composite reliability estimates, (0.793–0.914), all exceed the recommended 0.70 and 0.50 threshold respectively (cf. Fornell and Larcker 1981). Convergent validity was then ensured based on that confirmatory factor loadings (0.740–0.917) and squared multiple correlations (0.547–0.841) all exceeded the recommended 0.50 threshold (cf. Fornell and Larcker 1981). Completed measurement properties including descriptive statistics, confirmatory factor loadings, squared multiple correlations, t-values, Cronbach' alphas, composite reliabilities, average variance-extracted estimates (AVEs) are also shown in Table 1. A correlation table among all of the latent variables along with AVE of each latent variable is shown in Table 2. As shown in Table 2, squared correlations between latent variables (0.014–0.329) were not greater than any of AVEs (0.612–0.779) (cf. Fornell and Larcker 1981). Therefore, discriminant validity was established. In other words, each latent variable is well represented by its corresponding observed variables (convergent validity) while all latent variables are distinguishable one from another (discriminant validity), which is required to proceed the next step, structural model testing.

10.2 Structural Model Testing and Results

Given the reliability and validity of the measurement model was confirmed, a structural model was then estimated in order of the hypotheses. Two constructs, interest in science and public understanding of science were specified as exogenous variables while the other six variables were specified as endogenous variables. The model fit was good to the data: $\chi^2_{(df = 166)} = 432.590$, $p = 0.000$; GFI = 0.972; AGFI = 0.961; CFI = 0.986; NFI = 0.977; RMR = 0.027; RMSEA = 0.033.

The effects of interest in science were not significant on any of four constructs: ethical obligation ($\gamma = 0.048$, $p = 0.135$), perceived consumer effectiveness ($\gamma = 0.030$, $p = 0.409$), consumer responsibility ($\gamma = 0.042$, $p = 0.213$), and perceived knowledge ($\gamma = 0.054$, $p = 0.124$). On the other hand, the effects of public understanding of science were significant on all four constructs: ethical obligation ($\gamma = 0.246$, $p < 0.01$); perceived consumer effectiveness ($\gamma = 0.280$, $p < 0.01$),

Table 2 A matrix for discriminant validity examination

	1	2	3	4	5	6	7	8
1. Interest in science	*0.612*							
2. Public understanding of science	0.425	*0.687*						
3. Ethical obligation	0.167	0.246	*0.663*					
4. Perceived consumer effectiveness	0.138	0.225	0.508	*0.657*				
5. Consumer responsibility	0.155	0.229	0.465	0.466	*0.660*			
6. Perceived knowledge	0.120	0.160	0.306	0.228	0.138	*0.746*		
7. Attitude toward sustainable consumption	0.117	0.246	0.477	0.438	0.361	0.282	*0.779*	
8. Behavioral intention toward sustainable consumption	0.175	0.241	0.574	0.517	0.446	0.258	0.534	–

Note Italicized numbers in the diagonal line are the average variance-extracted estimates. Others represent correlations between latent variables

consumer responsibility ($\gamma = 0.254$, $p < 0.01$), and perceived knowledge ($\gamma = 0.163$, $p < 0.01$). Therefore, H1 was not supported while H3 was fully supported. The effects of ethical obligation were significant on attitude ($\beta = 0.234$, $p < 0.01$) as well as behavioral intention toward sustainable consumption ($\beta = 0.247$, $p < 0.01$). The effects of perceived consumer effectiveness were significant on attitude ($\beta = 0.287$, $p < 0.01$) as well as behavioral intention ($\beta = 0.265$, $p < 0.01$). The effects of consumer responsibility were significant on both attitude ($\beta = 0.109$, $p < 0.01$) as well as behavioral intention ($\beta = 0.106$, $p < 0.01$). However, the effects of perceived knowledge were only significant on attitude ($\beta = 0.175$, $p < 0.01$) but not on behavioral intention ($\beta = 0.020$, $p = 410$). The effects of attitude were significant on behavioral intention ($\beta = 0.277$, $p < 0.01$). In summary, H5, H6, H7, and H9 was fully supported while H8 was partially supported. The aforementioned results from the structural model testing including the effect size and statistical significance of each of the paths is illustrated in Fig. 1.

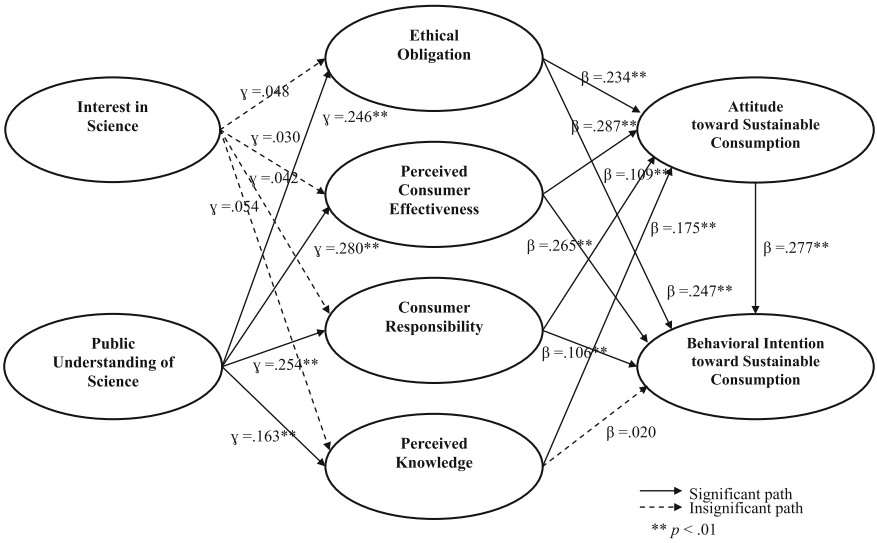

Fig. 1 A structural model for the effects of Millennial college students' attitudes toward science on sustainable consumption

10.3 Indirect Effects of Attitudes Toward Science on Sustainable Consumption

In order to test indirect effects of interest in science (H2) and those of public understanding of science (H4) on attitude and behavioral intention, decomposition tests using the bootstrapping method were followed. The indirect effects of public understanding of science on attitude ($\beta = 0.194$, $p < 0.05$) and on behavioral intention ($\beta = 0.219$, $p < 0.05$) were significant. However, the indirect effects of interest in science on attitude ($\beta = 0.034$, $p = 0.099$) and behavioral intention ($\beta = 0.035$, $p = 0.126$) were not significant. Therefore, H4 was supported while H2 was not supported.

11 Conclusions and Implications

The purpose of this study is to outline the impact of attitudes towards science on sustainable consumption. The results demonstrate that Millennial college students who more strongly believe all citizens must understand science and that science is important for their lives have more confidence in their ability to benefit the environment and society through daily decision-making as individual consumers. These students also feel more responsibility in environmental and social issues than those who less strongly believe in the importance of public understanding of science. Based on the results of the study, we can also conclude that Millennials who more

strongly consider the public understanding of science important are more likely to believe they are informed and knowledgeable about sustainability issues and personally feel a stronger obligation to choose more sustainable options. As a first attempt exploring relationships between attitudes toward science and sustainable consumption, one of the most important implications of this study is the contribution to our understanding of the role of attitudes towards science in education for sustainability. Educators such as Correia et al. (2010) have produced valuable roadmaps for introducing the entire study body to the scientific concepts that support sustainability education. The results presented here provide assurance that this support, even for non-science majors, impacts the motivation to engage in sustainable consumer behavior.

Another implication of the study comes from the expansion of the theoretical understanding of the relationship between science attitudes and ethical behavior, ethics being an important part of sustainability education (Biedenweg et al. 2013). These results strengthen and expand the findings by Ma-Kellams and Blascovich (2013) suggesting beliefs related to science can create an increase in moral and pro-social decision-making. Specifically, results show general support of science as a public good was positively related to each of the variables that push toward sustainable consumption behavior and indirectly but positively related to the intention toward sustainable consumption. One conclusion that can be drawn from these results is when policy makers, educators or businesses present the science behind their decision-making, they create the added benefit of increasing public understanding of science, which in turn provides support for ethical decision making for those consumers whose beliefs related to science were expanded.

On the other hand, interest in science, enjoyment in studying science or pursuing a career as a scientist, did not significantly affect any of those perceptions and beliefs related to sustainability and showed no indirect effects on attitudes and behavioral intentions toward purchases of sustainable products. Basically, Millennial college students do not need to be scientists or keen on studying science in order to build confidence in their ability or level of knowledge to make positive impacts on the environment/society. The recent push toward emphasizing STEM career paths can sometimes neglect to emphasize the role non-scientists play in supporting science. Here again, we can conclude that policy makers, educators or businesses using "science" to support decision-making related to sustainable product development can provide information to young consumers demonstrating the value of science in making ethical decisions and the role of scientists in ethical businesses without insisting all young people should want to personally enjoy science or choose it as a career.

Given national policy is focusing higher education on supporting economic development and technological innovation by turning out Millennial college students qualified for STEM careers, this study would make further implications specifically for higher education and policy makers. When policy makers are pushing for higher education to help meet STEM-related goals, the results of this study demonstrate that, when designing curriculum, educators should consider these STEM efforts a supportive part of meeting their sustainability goals. At a time

when, for a variety of reasons, some programs may be eliminating or drawing back science focused portions of their curriculums, the results of this study suggest building positive attitudes towards science, at least foster these beliefs that science is important to everyone and is not limited to certain fields is still valuable even when students are not being encouraged to go into science careers. Because this positive attitude towards sciences as a public good is important for creating the ethical attitudes related to sustainability that are a growing focus of many higher education programs even programs that place a lessor emphasis on science (i.e. Marketing) should pay attention to the general curricula that support the science attitudes of their students.

Besides conclusions for educators and policy makers, the results present implications for businesses marketing sustainable products targeting Millennials and that may or may not emphasize scientific approaches they have used in product development, logistics or marketing decision-making. If higher education, as the results suggest, is providing support for ethical decision making through attitudes towards science, businesses focusing on sustainability need to examine the scientific basis for assertions about their business. This is especially vital when some sustainable industry sectors are open "anti-science" (e.g. "no chemicals") and many brands are using poorly supported science or failing to consult scientists when asserting, perhaps falsely, their products are eco-friendly. An example of this is recent lawsuits by the FTC against brands labeling apparel products as made from "bamboo" and being "biodegradable", with these brands paying penalties to settle charges for violating the Textile Act and the FTC's textile rules on labeling. Retailers were advertising and selling products labeled as "bamboo" when in fact they were made from rayon (Federal Trade Commission 2013). "Bamboo" textiles are marketed as being "environmentally friendly," but the process bamboo pulp undergoes to turn into rayon is toxic and chemically laden, making it far from environmentally friendly (Yoneda 2009). Basic science education enables these young consumers to quickly understand how the chemistry behind the production of the fibers labeled as "bamboo" was identical to fibers labeled as "rayon" and how its biodegradation in the anaerobic environment of landfills is not possible. Businesses benefit from transparency about the science relevant to their supply chain not only because it makes the case for why their product is sustainable, but as the results of this study show because it also demonstrates why science itself is important and useful in society.

In conclusion, this study provides a baseline for sustainability educators in any discipline who are seeking to examine the role of their curricula in supporting sustainable consumption behaviors through positive attitudes towards science. Educators, especially in higher education, should be confident that even in curricula not intended to promote the enjoyment of science or careers in science, merely the support of science as a benefit to the public will increase sustainable consumption among their students.

11.1 Limitations and Future Research

This study selected two main domains of attitudes toward science in relation to sustainable consumption as a starting place in examining how the emphasis of scientific understanding and science education impacts the behavior of Millennial college students. Given this study provides empirical evidence of the significant impact of perceived importance of public understanding of science on sustainable consumption among Millennial college students, future research can expand research by incorporating other domains in attitudes toward sciences. This study was conducted with the entire student body of a university, providing future opportunities to replicate the work with universities in different parts of the world for comparison of the benefits of science attitudes within different university types (i.e. Polytechnics) or education systems (e.g. entrance examination for specific college majors). However, further research on the role of attitudes toward science in sustainable consumption could easily begin with a comparison of college students in specific programs of study in higher education that place either a greater or lesser emphasis on science (i.e. Chemistry vs Marketing), in order to determine the role program specific curriculum plays in the development of these attitudes.

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Authors Biography

Dr. Jiyun Kang is Associate Professor and Graduate Advisor of Merchandising and Consumer Studies in the School of Family and Consumer Sciences at Texas State University. Dr. Kang is a consumer scientist with expertise in multi-level modeling and scale development. Her area of research is focused on sustainable decision making, and her recent research projects include corporate social responsibility and branding, consumer psychology and sustainable retailing, and consumer leadership in the adoption of sustainable innovations. She teaches graduate and undergraduate courses on sustainable global sourcing, global fashion economics, and consumer behavior. The American Association of Family and Consumer Sciences named Dr. Kang as Emerging Scholar of the Year in both 2014 and 2012.

Dr. Gwendolyn Hustvedt is Associate Professor of Textiles and Assistant Director of Graduate Studies and Research in the School of Family and Consumer Sciences at Texas State University. She is a textile scientist with training in consumer behavior and product development. She introduced the use of experimental auctions in the study of consumer willingness to pay for sustainable products into the clothing and textiles field. Past projects also include the role of ethnocentricity in local apparel purchases, consumer sensitivity to biotechnology in the fiber supply chain and consumer adoption of sustainable laundry technology.

Dr. Stefanie A. Ramirez is Assistant Professor in the School of Family and Consumer Sciences at Texas State University. She received her doctorate in human ecology with a double concentration in Apparel Design and Merchandising from Louisiana State University in 2014. Her research interests include sustainability, consumer behavior with a specific focus on Hispanics, product and design innovation, and product development. She was hired at Texas State University in August 2014 where she teaches introductory courses in fashion merchandising as well as innovation and product development.

Student Perceptions on the First Masters in Education for Sustainable Development in Malta

Mark C. Mifsud

Abstract

The study is an in depth analysis of student perceptions on the first Master Course in Education for Sustainable Development in Malta. The course was carried out mainly through the use of lectures, fieldwork sessions and partly through an online virtual learning environment. The main aim of the course was to improve education for sustainable development knowledge, skills and values in educators and it mainly addressed local students from Malta through its contextualization. The study involved the use of mixed methodology, with questionnaires that focused on gathering the general picture and an in depth student evaluation written over a period of two weeks, with all the students to get deeper meaning and understanding. The responses were categorised and a number of themes emerged. The research identifies a number of different areas which were the prime motivators for carrying out the masters course, while it also highlights areas which can be improved, changed or realigned in order to make the course more effective and operative. A 4D MESD model is presented as a means of visualizing the various polarised dimensions of the findings. Considering the focus on student perceptions on an ESD master degree, this paper will be valuable to students and lecturers that are interested in innovative methodologies and in developing or evaluating Education for sustainable development courses.

Keywords

Master in education for sustainable development · Mixed methods · 4D MESD model · Perceptions · Course analysis

M.C. Mifsud (✉)
Department of Environmental Science, Centre for Environmental Education Research, University of Malta, Msida MSD 1252, Msida, Malta
e-mail: mark.c.mifsud@um.edu.mt

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1 Introduction

The effectiveness or otherwise of education for sustainability courses at postgraduate level has never been studied in the Maltese context. This study is an in depth analysis of student perceptions on the first such course in Malta. The course was carried out mainly through the use of lectures, fieldwork sessions and partly through an online virtual learning environment. The main aim of the course was to improve education for sustainable development knowledge, skills and values in educators and it mainly addressed local students from Malta through its contextualization. The perception of environmental issues, attitude and knowledge of students following such a course is of great importance as knowing what students think about environmental issues will encourage pro-environmental education (Pawlowski 1996) and also because the involvement of students in decision-making and the implementation of environmental and developmental programmes is critical to the long-term. Success of Agenda 21 (UNCED 1992);

2 Background to the Study

2.1 The Maltese Environment

The Maltese islands are a small archipelago located in the centre of the Mediterranean. The Maltese archipelago comprises three inhabited islands—Malta, Gozo and Comino—with a number of uninhabited smaller islands. The most serious environmental problems arise from the fact that Malta is one of the smallest states in the world and one of the most densely populated. The high population density is augmented further by high tourist arrivals of about 1.2 million yearly (Mallia et al. 2002). The main environmental issues on the island include waste production and management, reliance on fossil fuels for energy production, high private motor usage and freshwater production requiring a high energy input.

2.2 Local Environmental Education Development

Environmental education in Malta started off with environmental NGOs in the 1960s, mainly in response to the major environmental issues on the island. The awareness raising campaign was a very long affair, hindered in its development by a number of factors that lead to the slow growth of environmental education in the islands (Mifsud 2009). These factors include:

- the highly competitive educational system;
- the non-committal policy of the government;
- the colonial mentality.

In the formal education sector one of the major problems is the dominant educational ideology that suppresses creativity and rewards rehearsed words in examinations. Individual teachers who are interested in the environment may attempt to highlight environmental education, but the majority of teachers are hampered with little timetable time and lack of locally produced resources. Some materials currently used in schools were produced for use in other countries, and their transferability in the local context should be cautiously studied (Mifsud 2012).

With regards to the local government, it is apparent that the Maltese government mainly funds projects that have short term goals. Additionally, the lack of a clear national policy on environmental education has resulted in a waste of human resources and the shelving of long-term environmental education initiatives. Due to the fact that Malta was a colony for a long time, a number of anthropologists have indicated that the Maltese people seem to have a problem realising they own the island itself and its environment (Boissevain 1990). Subsequently, they do not attach much importance to the outside environment. Furthermore, although the Maltese native language is taught and understood by everyone, the English language is still considered to be more prestigious. The situation started to improve mainly in response to the requirements imposed on the country by the European Union. The government is now realising that the environmental education is an effective and long-term solution to ensure environmental sustainability. Many government officials speak of their commitment towards sustainability, but their concern is mainly short-term (Mifsud 2011).

2.3 The University of Malta and Environmental Education

The Centre for Environmental Education Research (CEER) was set up in 2004 with the intention of acting as a centre of excellence for EE research in the Mediterranean. The Centre for Environmental Education and Research seeks to catalyse change towards a sustainable society by providing opportunities for environmental education that empower citizens, irrespective of age, gender and socio-economic status, to actively participate in environmental decision making fora and in initiatives that promote a good quality of life.

CEER has been promised funds and a building, but, these took a long time to be forthcoming, mainly due to the ‘bureaucratic government system’ which is prevalent on the island. Nonetheless, CEER has now managed to launch the first masters in education for sustainable development in Malta. This three-year course targets teachers and education experts and aims to provide different perspectives of sustainable development, derived from the interaction of different environmental, societal and economic concerns (Mifsud 2011). This course and its first participants are the focus the present study.

Fig. 1 The structure of the MESD degree

2.4 The MESD Structure

The Masters in Education for Sustainable Development aims to present students with: different perspectives of (i) the environment, (ii) environmental education/education for sustainable development, (iii) the interaction between the environment & society, and (iv) sustainable development. The course is structured (see Fig. 1) through a philosophy that will enable students to study issues related to ESD in practice and 'in situ' in different environmental realities, and to experience different environmental, social, cultural, political and educational perspectives. Additionally, the Master helps students to access and critically evaluate ESD research and to develop the skills and attitudes necessary to promote sustainable lifestyles.

2.5 The Study

The study involved the use of mixed methodology, with questionnaires that focused on gathering the general socio-demographic student picture and an in depth student evaluation written over a period of two weeks, with all the students to get deeper meaning and understanding. The responses were categoried and a number of

themes emerged. The questionnaire and in depth questions were constructed following the examination of other instruments in the literature (e.g., Mifsud 2010; Barrett and Kuroda 2002; Eagles and Demare 1999; Gambro and Switzky 1999; Hodgkinson and Innes 2001; Kuhlemeier et al. 1999; Makki et al. 2003; Mogenson and Nielsen 2001; Fien et al. 2000; Pawlowski 1996). The research identifies a number of different areas which were the prime motivators for carrying out the masters course, while it also highlights areas which can be improved, changed or realigned in order to make the course more effective and operative.

2.6 Outline of the Methodology

There were eight participants in this study which represent the whole cohort of the first Master in Education for Sustainable Development course in Malta. The participants were forwarded a simple questionnaire to locate their socio-geographical characteristics, and eventually were given in depth student evaluation diary in order to write their feelings, perceptions and ideas about the course over a period of two weeks. This amount of time gave the students time to reflect on any changes of thought or behaviour that happened during the timescale of the course. A number of short questions were inserted inside the diary to act as catalysers for the students. The in depth evaluation was given to the students towards the end of the course, to ensure that they were exposed to all the course units. The structure of the personal questions was a follows:

1. Why did I do the course? What were my motivations?
2. Which were the main strengths and weaknesses of the course?
3. What is my overall opinion of the course?
4. Was the course structure and methodology suitable?
5. Did the course effect my knowledge, attitudes or behaviour?
6. Did I learn any skills during the course?
7. Would I change anything from the course?

The analysis of the in depth student evaluation diary was carried out following the two weeks afforded to students for data completion. The qualitative data analysis was based on an adaptation of the approach identified by Vaughn et al. (1996) who suggested four processes:

1. identifying the big ideas—the participants' words and ideas and the intensity with which the participants responded provide an initial framework;
2. unitising the data—identifying units of information from the text that will later become the basis for forming themes;

3. categorising the units—bring together the units of data identified above that are related to the same content;
4. identifying the themes—after considering the big ideas and the categorisation of the units the main themes are identified and refined.

The selection of the 'quotes' to include was informed by a professional judgement of what was important and significant for the context of the study. This, in turn, was based on the considerations of trustworthiness and transparency in qualitative studies, insights gained from the literature and the existing knowledge of environmental education in Malta and the Maltese environmental-political-educational context. One of the limitations of the study include the very small sample size, that render the results non generalizable but rather only applicable to this case study. Other limitations include the issue of time management and access to participants due to the study being carried out after the course finished.

Figure 2 illustrates the MESD students' backgrounds. A number of trends emerge:

- The majority of students have a non-science background
- The main entry qualification is a first degree related to education

Student	Age	Gender	Religion	Qualifications	Father's work	Mother's work	Status	Geographic location
1	40	female	Catholic	B.Ed	Teacher	Housewife	Married	North
2	38	Male	Agnostic	BA Sociology and PGCE	Project manager	Teacher	Single	Centre
3	26	Male	Catholic	BA geography	Retired	Housewife	Single	Centre
4	38	Male	None	BSc Physics/maths	Secondary Education level	Secondary Education level	Married	North
5	31	Female	None	Bed	Assistant director	Housewife	Single	South
6	38	Female	Catholic	BCom/ PGCE	Pensioner	Housewife	Married	South
7	26	Female	Catholic	BA/ Maltese PGCE	Soldier	Housewife	Single	Gozo
8	42	Female	None	Bed	N/A	Housewife	Single	South

Fig. 2 Socio Demographic characteristics of MESD students

- Most student's mothers were housewives.
- The students geographic origin was spread across the islands, but a peak was registered in the rather more polluted South region.

3 The Findings

3.1 Results of the Findings from the Quantitative Analyses

No previous study had ever been made on students following a Master in Education for Sustainability in Malta. The present study was of a mixed design. A short questionnaire with a number of course parameters was designed in order to give an overview of the course and to act as a precursor to the more extensive qualitative analysis. The quantitative results show a generally positive outlook from students in most course dimensions which were examined. Nonetheless, it is clear that students did find that the course required to much effort (87.5 %) and that group-work especially was not very effective (37.5 %). This was a clear weakness in the course which was also corroborated in the qualitative analysis. Conversely, students appear to be very satisfied with both feedback (87.5 %) and tutor interaction throughout the course (87.5 %). Other dimensions had an average response throughout the continuum, such as; course difficulty, supervision and the suitability of teaching environment. An illustrative set of quantitative findings from the study are found in Fig. 3.

3.2 Results of the Findings from the Qualitative Analyses

The present study has brought to the surface quite a range of views regarding the course, its effects and the Maltese environment in general. With no direct influence from the researcher, the participants introduced several broad themes, the main points of which are summarised below.

3.3 Main Themes

- Motivation for doing the course
- Personal Changes
- Behavior and attitude modification
- Course Dynamics
- Significant Life Experience
- Strengths and Weaknesses
- The Future

	Strongly agree	agree	Not certain	Disagree	Strongly disagree
The course covers the outlined scope, aims and objectives	75%	12.5%	12.50%	0%	0%
The course as a whole was well-structured	75%	25%	0%	0%	0%
The intellectual demands made on you were appropriate for the level of the course	62.5%	25%	12%	0%	0%
Were you satisfied with your own level of preparation and participation	75%	25%	0%	0%	0%
The course materials were adequate	62.5%	12.%	12.5%	0%	0%
The feedback was adequate	87.5%	12.5%	0%	0%	0%
Teaching methods were adequate	62.5%	12.5%	12.5%	12.5%	0%
The availability of reading materials listed in the bibliography was reasonable accessible	62.5%	12.5%	12.5%	12.5%	0%
The course was interesting	75%	25%	0%	0%	0%
The course was difficult	50%	12.5%	12.5%	12.5%	12.5%
The course required too much effort	87.5%	12.5%	0%	0%	0%
Adequate support was provided	75%	25%	0%	0%	0%
The Teaching environment was adequate	62.5%	12.5%	12.5%	12.5%	0%
Assignment supervision was adequate.	62.5%	12.5%	12.5%	12.5%	0%
Tutor interaction during feedback was adequate	87.5%	12.5%	0%	0%	0%
Group work was effective	37.5%	25%	12.5%	12.5%	12.5%
Individual work was effective	62.5%	12.5%	12.5%	12.5%	0%

Fig. 3 Quantitative results

3.3.1 Motivations for Doing the Course

Participants had a number of different motivations for doing the course, both from a personal, work related perspective and also from a more beneficial community wide perspective:

> *First and foremost, I did the course because I wanted to further enhance my education. At the same time I had been looking to start a Masters but most did not interest me. The Masters in ESD on the other hand caught my attention because it was something that interested me and something that I wanted to learn about.* (Student 1)

> *It was a time when I wanted to continue studying at the master level. Since the course is closely related to my first degree, I thought it would help me in my career and my main expectations were to strengthen my views as regards the environment and how to approach it. Obviously, my expectations once this course will finish is that I apply more the knowledge learned throughout the course whenever the need arises.* (Student 3)

One student mentioned that the subject has been an interest to her from a very young age and it was only a matter of time until she applied for the course. It appears that her decision was made long before.

> *From a very young age I have been captivated by my surrounding environment. This inner curiosity led me to explore it through my eyes as a child throughout the scholastic years. As I grew older I found myself searching on the web to understand certain topics that I had read about. Thus, it was an easy decision to opt for this course as it was a subject of interest to me.* (Student 7)

3.3.2 Personal Changes

Many students reported a variety of different personal changes in their belief systems that occurred throughout the course and because of the course. Some students were very vague in and did not manage to be concrete in their discussions while others were very focused and named a number of changes individually.

> *I definitely think that there has been a change in me. My way of thinking has definitely gone through a big change, and I feel that now I can be more objective on certain environmental issues (Student 1)*
>
> *I believe that the course helped me in being more empathic with people and in respecting their opinion even if this might be very different from mine and totally against sustainable development principles* (Student 4)
>
> *I think that the course helped me to improve my communication skills and in expressing my feeling and concern to others* (Student 6)

3.3.3 Behavior and Attitude Modification

Most students reported a number of modifications that occurred to their attitudes and behaviours throughout the course. The majority also acknowledged a positive increase in environmental knowledge.

> *The course certainly had an effect on my behaviour towards a lot of current environmental, social, economic and cultural issues. There were things that I used to do previously at the start of the course, which I used to do automatically.* (Student 1)
>
> *Though most of my attitudes were there before the course, the course helped in strengthening and possibly provide deeper reason to why they are there*. (Student 5)
>
> *First of all I started to make an effort to Comprehend all perspectives brought forward regarding SD issues and acknowledge their value. When reflecting on certain topics I began to analyze them in a holistic way and now I am aware that for SD to take place one has to take into account the 4 SD pillars. These led me to acknowledge my responsibility both as a Maltese citizen and as a global citizen and also made me believe that I can be an agent of change even with my limitations.* (Student 7)

3.3.4 Course Dynamics

A significant issue raised by the participants in their in depth writings was the examination and critical analysis of the course structure and its dynamics. There were a number of different viewpoints ranging from the underlying course philosophy to the actual deliver of individual units.

> *I believe that formative assessment is useful as on looking back I find myself bewildered by the work I managed to produce and the knowledge acquired throughout its built up. However I believe that in order to assess students more justly, transformative assessment should also be included*. (Student 7)
>
> *When it comes to course structure: in my opinion, the sequence of some units could have been different. There were some units that could have been done earlier, in the beginning of the course, rather than later on – for example research methodologies.* (Student 1)

Best methodologies employed was when the lecturers fostered debates which led us to reflect on our own experiences and make sense out of them. The challenging of assumptions lead to set out the learning process. (Student5)

3.3.5 Significant Life Experiences

All students gave a synoptic overall personal lived experience of the course, both in terms of its delivery, its effects and its shortcomings. Some students also made a number of suggestions based on their experience as postgraduate students of the said course.

My overall opinion of the whole course is definitely a good one. The course is certainly an interesting one and should definitely be continued and maybe be more promoted to encourage more further student, because it is certainly a course that would be of interest to a wide spectrum of students coming from all walks of life. (Student 1)

Sometimes I find myself trying to convince people or educate them in different ways – even by just exposing them to realities they never had thought of. I feel part of a cause. (Student 2)

It reinforced my attitudes towards the environment – more respect towards the environment. This course instilled in me more social responsibility towards the environment through little things that we do every day. (Student 3)

Though it was very tough and demanding, I am very happy with my experience and the quality of the course in general. I really value the fact that it expanded my horizon and my world view on a lot of issues. The only grey cloud was that the majority of us did the same job for a living, thus slightly limiting the diversity of backgrounds from where we came. (Student 5).

3.3.6 Strengths and Weaknesses

Students mentioned a large number of areas which were considered to be strengths and others that were considered to be weaknesses. The following are extracts that illustrate the wide ranging weak and strong areas as identified by the participants:

Weak areas

- Sustainable Development as a subject is too vast
- Some overlapping content in some units
- Not enough time for debate
- Methodology used during lectures was not always engaging
- Overall there were no irrelevant study units – but some units seemed to overlap in content
- Lack of group-work in assigned work
- More outdoor experiences

Strong areas

- Course coordinators very helpful and understanding

- Great team where it comes to both the students and the lecturers
- Course material very interesting
- Lecturers availability
- Small groups of students
- Lecturers different and practical experiences of ESD
- A number of units were thought provoking and challenged some pre conceived ideas that I had

3.3.7 The Future

When discussing their opinion on the future some students focused on discussing the course future, others discussed the future of the area as an academic subject while others discussed the impact of such a degree and the expertise it brings to the wider community.

> *I hope that CEER plans to carry out seminars and refresher courses for us students in order to keep up to date and in touch on what is going on in ESD. This could prove to be a valuable opportunity for us ESD educators to meet and share experiences, good practices and concerns that we might have.* (Student 4)

> *In the future, it is of utmost importance of keeping a balance between economic, social, environmental and cultural development (Student 5)*

> *Sustainable development is a lengthy process and one cannot think that it can be achieved overnight. Such thinking usually leads to people being disheartened to loose faith in what they are doing. (Student 6)*

> *I suggest that local issues should be explored more deeply throughout the course by giving students the opportunities to have more practical research sessions. (Student 7)*

3.4 The 4D MESD Perspectives Model

Informed through the findings of the present qualitative research, a model of the Course perspectives, the 4D MESD Perspectives Model is being proposed. It has to be understood that this model is not being proposed as a universal model but a localised model on a particular cohort of people that is: Students following the MESd course. From the examination of the in depth student writings, four distinct axes of perspectives started to emerge with regard to the course standing:

- Extrinsic Motivation—Intrinsic Motivation
- Dynamic Path—Static Path
- Collective Benefit—Personal Benefit
- Attitudinal Change—Behavioral Change

- Extrinsic Motivation—Intrinsic Motivation

Some participants explain that the main reason for doing the MESD was for the possibility of getting a better job in the future, while others said that there main interest was in the subject of sustainability. On the student motivations included both intrinsic and extrinsic motivators, and a continuum line can be designed to accommodate all the student responses from the purely intrinsic up to the purely extrinsic motivators.

> *I did the course mostly to learn about areas that I was already reading about. I expected to become more knowledgeable in these areas and now I'd like to use them for the best, preferably by finding a related job.* (Student 2)

> *I expected that through this course I would expand my knowledge about sustainable development issues ad challenges which, in turn will help me to be a better citizen who acts accordingly in the best interest for a sustainable world.* (Student 4)

> *I was motivated to do the course due to a personal interest in ecology and preserving the natural environment. Moreover, I wanted to pursue my studies is something that interested me personally rather than just for better job prospects since I like my present job. However, obviously if job opportunity in line with ESD arises in the future I will highly consider it.* (Student 5)

- Dynamic Path—Static Path

Participants appear to be interested to various degrees in change. Some have a genuine interest in each other and to further improve all aspects of activities, and have a genuine interest in 'saving the planet'. These participants appear to be active or even pro-active with regard to the events unfolding before them and argued in favour of their own possible contribution to increase environmental awareness in the family, at school and at work in the foreseeable future. On the other hand, some participants think that 'things are not that wrong' as they are currently, make vague remarks to maintain the status quo', and they appear to be somewhat passive to the events unfolding before them.

> *I believe that I had the experience to study with a very good group of colleagues. Most of the time we shared documentation and paper needed for credits in a true spirit of a collaborative approach. If group dynamics weren't so good, I feel I would have missed out of some of the benefits of this experience.* (Student 4)

> *For a sustainable world everyone has a role to play and thus education for all is crucial for reaching sustainability.* (Student 7)

> *When I applied for the this course, I wanted to learn more about ESD, an to grow on a personal level, both spiritually and academically. I don't know what to expect now really… I feel more confident in the subject and im able to pass on the values, skills and knowledge, I gathered throughout this course to others and to my pupils at school. One of my main concerns will be passing on the values in an unofficial way to my colleagues at work since I feel they lack the skills, knowledge and beliefs to handle ESD.* (Student 5)

- Collective Benefit—Personal Benefit

Some of the participants, to various degrees, view the course as endowing a number of personal benefits to the individual, such as an improved critical mind and improved job prospects. Nonetheless, a number of students have a much wider view of the course benefits and put the community as the main beneficiary of the activity.

> *Yes, because I really enjoyed myself doing the new job and basically instead of using the course to move forward in terms of promotion I am using what I have learnt for self-improvement and to be in a better position to offer a better service where I am needed.* (Student 4)

> *The course equipped me with a critical mind in tackling sustainable development issues* (Student 7)

- Attitudinal Change—Behavioral Change

Although all students stated that the course increased their knowledge in a number of different environmental dimensions, it is clear that not all students recorded changes in behavior. Actually some students reported changes in their attitudes only, while others reported changes in behavior only. Only a few students reported changes in both dimensions.

> *Nowadays I reflect much longer and consider more things before making any type of decision. I feel more responsibility in my behaviour.* (Student 2)

> *I now believe that small changes can bring large changes in the future. (Student 8)*

The majority of perspectives appear to occupy various points created by the intersection of these four continuum lines, around a transition area between the main polar views. No attempt has been made in this research to statistically analyse the responses in order to pinpoint various locations on the model that would represent groups of students, but rather the model represents the confines of all the perceptions that where discovered Fig. 4.

4 A Way Forward

The research has identified a number different areas of student perceptions with regard to the master course. These areas include; 'Motivation for doing the course', 'Behavior and Attitude Modification' and 'Significant Life Experience' amongst others. Additionally a number of socio-demographic trends were identified from the quantitative analysis, such as that the majority of students had a non-science background and that a majority of students' geographic origin was from the rather more polluted South region. Following further analysis, the findings were combined in a 4D MESD model as a means of visualizing the various polarised dimensions of the findings. Through the study a number of suggestions for further course improvement emerged. The suggestions arise from the examination of the data and

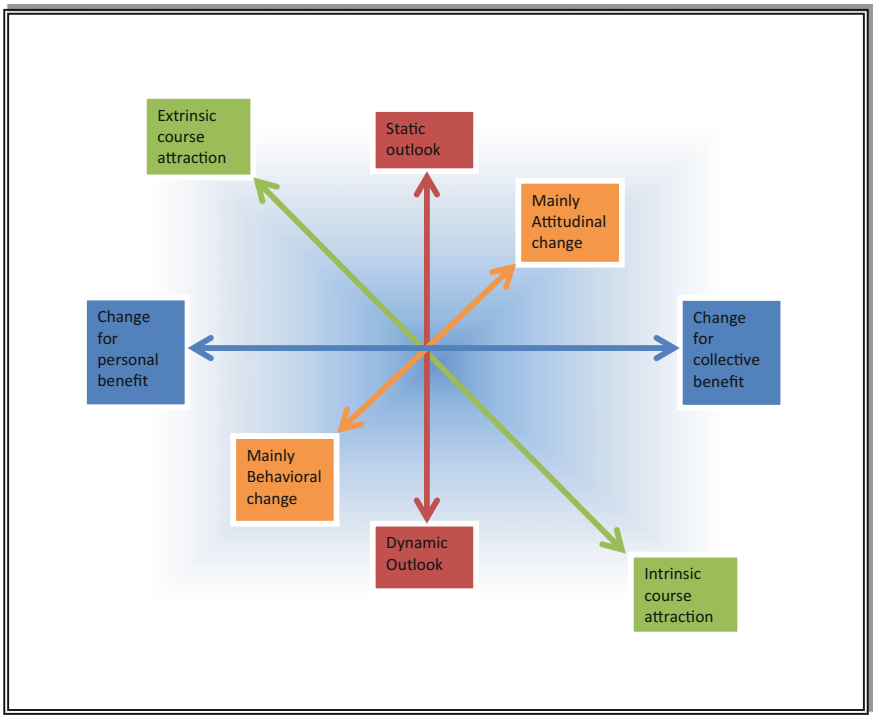

Fig. 4 The 4D MESD Perspectives Model

the feedback given by the students and include the 'Increase in group work activities in the course', 'the sensitisation on the importance of collective behavior through improved course structure', the facilitatation of interdisciplinary work and the exchange of expertise on sustainable development both within the course and in the local community, and by means of outreach to other communities, nationally and internationally' and 'the production of educational materials specific to sustainable development as individuals and as groups'. All these suggestions should examined for incorporation in the next course in order to increase effectiveness. It is suggested that more research is carried out on future student cohorts of the MESD to test and further improve the 4D MESD model. Comparative research with other similar masters in the Mediterranean region should also be carried out in order to build a more regionally sensitive perceptions model.

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Author Biography

Mark C. Mifsud is a Lecturer at the Centre for Environmental Education Research at the University of Malta. He is a Chartered Biologist, a Chartered Environmental Scientist, a Chartered Science Teacher, a Certified Wildlife Photographer and a Prince II Certified Practitioner with more than 20 years experience in Environmental Sciences, Environmental Education and Sustainable Development. Mark is presently the coordinator of the Masters in Education for Sustainable Development and his main areas of research include youth and the modelling of environmental knowledge.

Sustainability at Universities: Degrees of Institutionalization for Sustainability at German Higher Education Institutions—A Categorization Pattern

Kathrin Rath and Claudia T. Schmitt

Abstract

Fostering sustainability at universities, and especially its institutional implementation has increased worldwide in recent years due to the global challenges that come along with climate change, the growing consumption of natural resources, and the transformation of science as well as educational systems. In Germany, different approaches of implementing the notion of sustainability at higher education institutions (HEIs) can be observed: Some HEIs focus on topics of sustainability in their curricula and study programs and conduct corresponding research projects, others relate to sustainability as an overall governance concept and define their organizational profiles accordingly. Some HEIs use a systematic Whole Institution Approach to implement Education for Sustainable Development (ESD) while some others have redesigned single parts of their institutional structures, e.g. to reduce their universities' ecological footprint. How can the various activities for sustainability at HEIs be typologized and evaluated? Based on a screening of sustainability reports and websites of German HEIs, this paper will identify four different degrees of sustainability-institutionalization in order to offer a categorization pattern that can be used for a rough estimation as well as a self-assessment-tool. This paper also specifies related prototypical examples to showcase various approaches to

The authors contributed equally to this paper.

K. Rath (✉)
Hamburg University of Applied Sciences, Research and Transfer Centre "Applications of Life Sciences", Ulmenliet 20, 21033 Hamburg, Germany
e-mail: kathrin.rath@haw-hamburg.de

C.T. Schmitt
Universität Hamburg, Kompetenzzentrum Nachhaltige Universität (KNU)/ Center for a Sustainable University, Mittelweg 177, 20148 Hamburg, Germany
e-mail: claudia.schmitt@uni-hamburg.de

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institutionalize sustainability at German HEIs. Limitations and further research perspectives are discussed. Additional questions that may be considered in order to enhance HEI's internal sustainability actions are posed.

Keywords
Higher education institutions · Sustainability · Institutional implementation of sustainability · Sustainability reporting

1 Introduction

Against the backdrop of rising societal challenges such as climate change, resource scarcity, poverty, and social injustice the globally discussed topic of sustainability continues to be highly relevant. At the end of September 2015, as part of the UN Sustainable Development Summit, 17 Sustainable Development Goals to be achieved by 2030 were agreed on by the international community as to provide a framework for the future development of society and to guarantee the continuation of the Millennium Development Goals.[1]

As institutions of society, higher education institutions (HEIs) such as universities and universities of applied sciences, which build the core of the science system including their three task fields of research, teaching and services, are also responsible to contribute to the future-oriented development of society. A future-oriented development nowadays is increasingly guided by the principle of "sustainability" (HRK position paper 2009, p. 2). Therefore, it can be assumed that sustainability-related issues are taken into account in almost every HEI today and that the awareness for sustainability at HEIs is definitely increasing (cf. Lozano et al. 2015); however, in which form and to which extent this is happening exactly, has to be specified in more detail.[2] Meanwhile, a common practice is the integration of sustainability issues into research, the inclusion of sustainability-oriented topics in teaching, and the organization of sustainable campus operations (see e.g. Deutsche UNESCO-Kommission 2011). Moreover, developing and/or signing declarations on sustainable development has become more and more attractive for HEIs (cf. Wright 2002; Lozano et al. 2013).

[1] https://sustainabledevelopment.un.org/index.php?menu=1300.

[2] As far as the authors of this paper know, there aren't any similar considerations yet about specifying types and degrees of institutionalizing the notion of sustainability at HEIs, although it has to be recognized that there is a growing number of valuable publications dealing with conceptualizations and appropriate ways of operationalizing sustainability at HEIs, e.g. the works of Müller-Christ (2013), Holdsworth and Thomas (2015), Palma and Pedrozo (2015) and Lozano et al. (2015).

Leal Filho (2015, p. 5–6) differentiates between three main manifestations of implementing sustainability in universities which are currently just slightly overlapping: (1) An individual approach, in which the implementation of sustainability within a university is driven by individual persons; (2) A sectoral approach which describes that sustainability approaches are only implemented by individual faculties; and (3) An institutional approach, which comprises a commitment from the whole institution with regard to sustainable development.

The aim of this paper is to expand those considerations, to present and to discuss different approaches of institutionalizing sustainability at German HEIs, and to offer a rough classification scheme with respect to the degree of institutionalization at HEIs. The paper will provide an overview of sustainability-related activities and their institutionalization at German HEIs. Based on this, reflections on how to further operationalize the institutionalization degree of sustainability at HEIs will follow. Therefore, the focus of this paper is based on the question: Which forms of institutionalization of sustainability at German HEIs do currently exist and to what extent could they be typologized? The primary aim of this paper is to contribute to further discussions of sustainability processes and their implementation at HEIs and to encourage clarification and research on processes of institutionalization within the context of sustainability.

2 Approach

This paper is based on the assumption that HEIs that are publishing sustainability reports are already on the way to institutionalize the notion of sustainability and can trigger incremental changes, cf. Ceulmans et al. (2015). (Of Course, also HEIs without sustainability reporting or HEIs that have possibly integrated the topic of sustainability in other reports may be on a way of institutionalizing sustainability; however, at this point, they remain unconsidered due to constraints that come along with the chosen and applied approach).

As a starting point for the considerations in this paper, the study of Sassen et al. issued in 2014 is used. As to this study, sustainability reports from 13 German universities were available at that time.[3] These 13 sustainability reports were screened by the authors of the present paper in order to identify documented structures and/or approaches regarding the institutionalization of sustainability at the respective universities. In addition, and with the same objective, homepages and organizational charts of the respective universities were sighted. Here, a search for the keyword "sustainability" at the start website (and possibly secondary sites) took place. Furthermore, there was a search for faculty and/or research activities with a special focus on sustainability. Moreover, the organizational charts of the respective

[3]Currently, more sustainability reports are available from even more German HEIs. The authors of this paper decided to limit information about HEIs to those out of the study from Sassen et al. (2014) due to practical reasons.

universities were reviewed in order to see whether sustainability, environmental or energy managers or sustainability departments are in place at the respective university. All in all, the proceeding described above is not meant as a methodologically comprehensive study. Nevertheless, the selected approach allows a more in-depth look at existing, documented sustainability activities and structures of the respective institutions.

As a frame of reference for the understanding of the term "institutionalization" of sustainability or sustainability activities in this paper, the following has been defined[4]: A legitimate and stable long-term structure within a HEI which sets the frame that the sustainability activities of the respective HEI are deliberately designed, ordered, directed, and that their implementation is supported within the HEI.

Overall it is distinctly clear that HEIs internally develop the complex and abstract topic of sustainability in individual and quite different ways and therefore also deal differently with the concern and the requirement to institutionalize sustainability. In some HEIs, sustainability is targeted input to individual curricula and study programs whereas in other HEIs subjects related to sustainability are ubiquitous and can be referred to as a "Whole Institution Approach" which covers all areas of the university. At some HEIs, sustainability is perceived as governance concept and anchored in the steering apparatus of the university, while other universities dedicate themselves directly to the topic of sustainability with their complete organizational profile.

Table 1 in the appendix summarizes the results of the screening of the 13 sustainability reports and of the websites of the universities concerned and it allows a more detailed insight to the database for the subsequent considerations.

3 Degrees of Institutionalization of Sustainability at German HEIs—A Rough Systematization

Using the results of the screening mentioned above, the authors of this paper suggest the following systematization pattern—which is meant to offer a rough orientation considering different degrees of sustainability-institutionalization at HEIs:

I. Degree of Institutionalization (DI) 1: single sectoral activities dealing with sustainability issues (activities are not interconnected)
II. DI 2: a governance-concept of sustainability
III. DI 3: Whole Institution Approach
IV. DI 4: Sustainability as an institutional profile

[4]A similar comprehension as put forth by Heinrichs and Laws (2014) in analyzing German Federal Policy in general, though no explicit definition of "sustainability institutionalization" is given in that paper.

Table 1 Results of the screening of 13 sustainability reports and of the websites of the Universities/Universities of Applied Sciences

German Higher Education Institution (HEI)	Title of the sustainability report incl. (publishing date) and website address of the HEI	Documented structures/approaches of institutionalizing sustainability
Carl von Ossietzky Universität Oldenburg Carl von Ossietzky University of Oldenburg	Nachhaltigkeit an der Carl von Ossietzky Universität Oldenburg – Ein Bericht von Studierenden (2013) www.uni-oldenburg.de	SR • Accompaniment of the process SR by "Team Sustainability Reporting" (members: Researchers + Teachers + "practitioners") (SR mainly developed by students + editorial team) + "Team Energy Management" (administrative staff + students) (Students Initiative) • Specific courses with S reference: Master Cluster Environment and Sustainability (7 Masters courses with specific thematic priorities) Website • SR to find among "university"/"profile" • Research on S named as a research priority
Universität Kassel University of Kassel	Universität Kassel Heute für Morgen – Erster Bericht zur Nachhaltigkeit in Forschung, Lehre und Betrieb (2014) www.uni-kassel.de	SR • Reporting by Editorial Team • Further development of research priorities and programs related to S • Thematically focused competence centres • Ecological S: establishment of a centralized Commission as an advisory body for the university's Steering committee • Social S: representatives of different status groups composed in different commissions assist the university's Steering committee (e.g. Equality Commission, strategic human resource development etc.) • Officer for environmental S • Vice-Presidents are responsible for social aspects of S Website • Emphasizing the following topics in "About us": –Environmental U –Equality, family and diversity • Anchoring of S in the university's overall concept available in German + English • SR available • S is not visible in the organization chart

(continued)

Table 1 (continued)

German Higher Education Institution (HEI)	Title of the sustainability report incl. (publishing date) and website address of the HEI	Documented structures/approaches of institutionalizing sustainability
Hochschule für nachhaltige Entwicklung Eberswalde Eberswalde University for Sustainable Development	Offengelegt. Bericht zur nachhaltigen Entwicklung unserer Hochschule 2012/2013 (2014) www.hnee.de	SR • HNEE relies exclusively on key areas directly related to S (energy efficiency, regional management, nature conservation, sustainable tourism, organic farming etc.) • 17 degree programs with directly related to S • Principle of HNEE: S as an integrative and overall University concept Website • The concept of HNEE as an UAS for S is apparent (in specialist areas, research areas, dedicated persons etc.)
Universität Duisburg-Essen University of Duisburg-Essen	Jahresbericht 2010/2011 – Nachhaltige Entwicklung an der Universität Duisburg-Essen (2011) www.uni-due.de	SR • SR as a result of a project at the university (project BENA (inventory of sustainability/supported by the Rector of the university)—BENA is initiated by the Initiative for more Sustainability eV—founded in 2005 as a student university group • Inventory of S activities by students, graduated volunteers and employees • SR serves to initiate internal dialogue • University commitment to S: Signed Copernicus Charter, 2004 Establishment of a group which bundles expertise in the field of "sustainable development" • Appointment of an S representative in 2009 (but acts purely as a point of contact for internal and external S actors, has an intermediary role, mandate is to build networks + initiate measures related to S) • Structure: Initiative for more Sustainability eV, S representative and BENA project established • Next steps: Systematic integration of S in the strategic management of the U Website • Structures of S is not clearly obvious on the homepage—only diversity management and gender portal named • S structure not included in the organizational chart (except Equal Opportunities Officer)

(continued)

Table 1 (continued)

German Higher Education Institution (HEI)	Title of the sustainability report incl. (publishing date) and website address of the HEI	Documented structures/approaches of institutionalizing sustainability
Leuphana Universität Lüneburg Leuphana University of Lüneburg	Schritte in die Zukunft – Nachhaltigkeitsbericht 2013 (2014) www.leuphana.de	SR • S is part of the university culture • Own sustainability faculty established • Definition of sustainability guidelines within the U • 2013 Award for the successful integration of S in all spheres of academic life at the U • Target: development towards a "Sustainable University" Website • S as a focal point quickly obvious • S anchored in the mission statement (incl. concrete description of what S means in detail for the U), own faculty
Universität Bremen University of Bremen	Nachhaltigkeitsbericht außen 2010 (2010) www.uni-bremen.de	SR • Definition of sustainability and environmental guidelines—including: institutionalization of sustainability and environmental protection: –Bodies of the U support in the implementation of S in research, teaching, administration and student operation –Development of a S and environmental Programme in which objectives and measures are described and communicated –Program serves as basis to continually improve S and environmental performance of the U • Artec Research Centre for S as an interdisciplinary center of the U Website • S is (relatively far back) cited as a key objective of the U • Artec named as Research Centre and central scientific institution for S in the organizational chart of the U
Katholische Universität Eichstätt-Ingolstadt Catholic University of Eichstätt-Ingolstadt	Nachhaltigkeitsbericht 2013 (2014) www.ku-eichstaett.de	SR • Topic of S defined in the strategic paper "ESD—Vision and mission of the Catholic University of Eichstaett-Ingolstadt" published in 2010 • S as a core element in research, teaching and campus life

(continued)

Table 1 (continued)

German Higher Education Institution (HEI)	Title of the sustainability report incl. (publishing date) and website address of the HEI	Documented structures/approaches of institutionalizing sustainability
		• Award of the U's S concept in 2013 as a UN Decade project • Sustainability Officer = professor appointed by the university management (+steering group) + Campus Environment Manager in place • Chancellor as a contact person for the entire area of S Website • Topic of "Sustainable Catholic University" easy to find ("Our Catholic University") • S concept and SR available • Concrete institutionalization clear and significantly plausible, however, S is not included in the organizational chart
Universität Hamburg	Nachhaltigkeitsbericht für die Universität Hamburg 2010/2012 (2011) www.uni-hamburg.de	SR • SR issued by non-profit student association Oikos Hamburg • Establishment of the "Competence Centre Sustainable University" (KNU) in late 2011 Website • Link to the KNU easy to find ("Profile—Sustainability")
Hochschule Zittau/Görlitz Zittau/Görlitz University of Applied Sciences	Nachhaltigkeitsbericht der Hochschule Zittau/Görlitz 2009 – "Bewusst werden, bewusst handeln" (2010) www.hszg.de	SR • Environmental Management Officer + Environmental Coordinator/Specialist on Work Safety in place • Focus of S initially on the operation/environmental aspect of S • Environmental Policy Statement of the UAS in the SR • Statement on "sustainable construction" at the UAS in the SR Website • Under "College—Management Systems" the Environmental Management System including S can be found

(continued)

Table 1 (continued)

German Higher Education Institution (HEI)	Title of the sustainability report incl. (publishing date) and website address of the HEI	Documented structures/approaches of institutionalizing sustainability
		• S is not explicitly included in the mission statement of the UAS nor named in the structure—only Institute of Ecology and Environmental Protection is named
Hochschule Trier – Umwelt Campus Birkenfeld Trier University of Applied Sciences - Environmental-Campus Birkenfeld	Nachhaltigkeitsbericht 2012 – Grünste Hochschule Deutschlands - Die drei Säulen der Nachhaltigkeit "Ökologie, Ökonomie und Soziales" am Umwelt-Campus Birkenfeld (2012) www.umwelt-campus.de	SR • Focus "Environmental Campus" • Only "Zero Emission University" in Europe • Title "Greenest University" in 2011 (followed by Eberswalde (2) and Leuphana (3)) • S council (10 persons) established which includes all departments of the Environmental Campus which deal with S—1st priority of the council "to address environmental issues that are relevant to the campus" • S representative as a member of the council Website • Explanation of the Green Campus concept on the website ("Campus—Campus Green concept")—SR also available here • Divisions with S relation
Hochschule Heilbronn Heilbronn University	Aspekte der Nachhaltigkeit 2011 (2011) www.hs-heilbronn.de	SR • Council for Sustainable Development at the UAS • SR written as a Bachelor thesis • S included in the mission statement of the UAS • Direct assignment of the S management system and the S representative (organized within a department) to the UAS Rector—supports the UAS steering board with S related issues • S unit organized within the student council • Senate Representative for SD (organization of lectures, seminars, events, etc. on the subject of S in addition to the curriculum + member in overarching networks) • SD manager (50 %) position = continuous development of UAS in research, teaching and operations related to S

(continued)

Table 1 (continued)

German Higher Education Institution (HEI)	Title of the sustainability report incl. (publishing date) and website address of the HEI	Documented structures/approaches of institutionalizing sustainability
		• "Studium Generale" and lecture series on topics related to man—environment—future Website • S included as a fundamental value in the mission statement of the UAS (but not further mentioned in the organizational chart) • S with a particular focus on transport and logistics compiled in a research institute within the UAS • SR not available on the website
Universität Bayreuth University of Bayreuth	Nachhaltigkeitsbericht Universität Bayreuth 2007/2008 (2008) www.uni-bayreuth.de	SR • SR issued in collaboration with student organization, working group "Sustainable Economy"/oikos Bayreuth eV (U Administration supplied data) • BayCEER (Bayreuth Center of Ecology and Environmental Research)—cooperation of 20 professors from the fields of biology and earth science • 2005 Foundation of the "Research Centre for the right for sustainable development" (organizing lectures (e.g. S in frame of the German political system) and implementation of projects) • S in study courses + research projects Website • S as a field of research within U profile: Governance and Responsibility • Additional profile fields: Ecology and Environmental Sciences; Energy Research and Energy Technology • S not mentioned in the organizational chart and not explicitly mentioned in the mission statement of the U

(continued)

Table 1 (continued)

German Higher Education Institution (HEI)	Title of the sustainability report incl. (publishing date) and website address of the HEI	Documented structures/approaches of institutionalizing sustainability
Technische Universität Kaiserslautern University of Kaiserslautern	Nachhaltigkeitsbericht TU Kaiserslautern 2013/2014 (2015) www.uni-kl.de	SR • Project "Sustainable University of Kaiserslautern" established at the U to steer the sustainability process at the U in a structured way • SR as a base and basis for discussion for the development of a SD strategy Website • S not mentioned on the website

DI Degree of Institutionalization
HEI Higher education institute
ESD Education for Sustainable Development
SR Sustainability Report
S Sustainability
SD Sustainable Development
UAS University of Applied Sciences
U University

The following section describes this systematization in more detail (criteria for different degrees of institutionalization). Moreover, each of the suggested DIs is specified by a prototypical example of a German HEI to illustrate the criteria of institutionalization.

I: Degree of Institutionalization 1: sectoral single activities for sustainability
This DI can be identified by the presence of single sectoral activities for sustainability at a HEI. These activities may take place within research, teaching and/or service operations. Nevertheless, these activities for sustainability are not interrelated or coordinated. Thus, sustainability related activities are given in one or more fields of action but they are only institutionalized to a very small degree: Integration of these activities into the organization's structures is barely given. Although single and sectoral activities for sustainability are important and necessary to foster the notion of sustainability in the HEI context, more structured and in-depth approaches are needed to truly institutionalize sustainability in the long run.

DI 1 can be described as subsuming all HEIs that do have various single activities for sustainability either in research, teaching or operation—separately or in all of these fields together. A HEI for example, which offers different student courses on sustainability topics or that is active within ESD in general, but doesn't clearly address sustainability within service operations and administration, would be categorized as DI 1. Even if there are activities in research for sustainability and sustainable development in education/teaching and operations all together, a HEI

would be categorized as DI 1 as long as there is a missing clear structure of connecting and integrating these several sustainability activities for the whole HEI. This DI more or less reflects the implementation of sustainability as described in approach 1 and 2 by Leal Filho (see above).

Based on the authors' screening of 13 German HEI sustainability reports (see section "Approach"), examples for addressing sustainability topics in teaching and education in general are: Announced lectures and/or seminars for sustainability; degree programs that deal with sustainability from a disciplinary or an interdisciplinary point of view. Most HEIs also relate to sustainability as a research topic and thus are—more or less active—in scientific inquiries on sustainability issues. Some HEIs pool degree programs and research on sustainability to build so called Clusters. Examples for addressing sustainability in service operations and administration are: explicitly including ecological considerations on campus; holding certificates for eco-management systems or similar activities.

Exemplifying DI 1, the University of Oldenburg serves as a prototype description: At the University of Oldenburg seven Master programs related to sustainability issues (e.g., "European Master in Renewable Energy", "Water and Coastal Management", "Sustainability Economics and Management") are pooled within a so called "Master Cluster Sustainability", focusing on education and teaching for sustainable development. Students of any one of the Cluster programs can choose to take classes of other programs beyond the Cluster, therefore qualifying interdisciplinary according to their special interests. A focus is given to transdisciplinary exchange between students and practitioners. The Master Cluster is described as being the centerpiece of ESD at the University of Oldenburg (sustainability report Universität Oldenburg 2013, p. 17). Research on sustainability-related topics is also given, emphasizing scientific marine and costal research as well as renewable energies (sustainability report Universität Oldenburg 2013, p. 20). Moreover, specialized research centers such as "COAST—Center for Ecology and Sustainability Research" exist at the University of Oldenburg. According to the university's 2013 sustainability report, there is also engagement for implementing sustainability activities within service operations. All in all, there are a lot of sustainability-related activities to be found at the University of Oldenburg, in research as well as in teaching and campus management. But neither the considered sustainability report nor the university's websites provide information on a superordinate structure aimed at integrating these various activities and thus no clear institutionalization of sustainability can be found. E.g., there seems to be no declared sustainability officer responsible for fostering sustainability issues for the university as a whole.

II: Degree of Institutionalization 2: Governance Concept of Sustainability DI 2 refers to an institutionalization of sustainability at a HEI where there are first steps of building a structure for implementing sustainability-related actions by taking account of them as a baseline for a concept of HEI government. Thus, DI 2 exceeds DI 1 clearly, because the topic of sustainability in this case has become so important that it gets commitment from higher levels of the HEI management. Sustainability is fixed as a core value of the university and structures for transformative processes

are set up. DI 2 is given when provosts explicitly and systematically refer to sustainability as a key concept for their HEI's orientation and foster HEI development towards integrating sustainability issues in all given structures. Indicators for DI 2 are, for example: an overall institution or a committee that addresses sustainable development of the HEI as a whole (not only within single faculties or selected fields of action) is given; there is a sustainability officer or a similar position responsible for sustainability-related topics within the HEI administration. I.e. structures for specifically and continuously working on the institution-wide implementation of sustainability in research, education and operations exist and are significantly involved in governing further steps of the HEI. All in all, DI 2 refers to basic steps towards a long-term implementation of structures for sustainability-related actions which still are under formation. But—in differentiation to DI 3 (see below)—there aren't any central departments for sustainability and for the coordination of overall sustainability issues resources aren't allocated yet. Networks of faculties and other HEI department specialized on sustainable development are only rudimentary and still only a small number of participants and players are involved. There is more of a connection between sustainability-related activities in research, teaching, and operations than there would be within DI 1, but still these connections are only loose, rather uncoordinated and unstable.

Exemplifying DI 2, the University of Applied Sciences Heilbronn serves as a prototype description: Sustainability is explicitly mentioned in the mission statement of the Heilbronn University of Applied Sciences. There is an organizational sustainability council which initiates and coordinates sustainability-related activities and has a consulting function for sustainability topics at the university. A representative for sustainable development authorized by the university's senate can be contacted by staff and students for questions and claims concerning sustainability and also offers presentations and additional programs on sustainability topics. A sustainability officer organized within a department directly linked to the rector supports central sustainability activities of the university. Additionally, an internal sustainability consultant promotes the university's transformational processes towards sustainability implementation in teaching, research, and operations (sustainability report Hochschule Heilbronn, S. 6–7).

III: Degree of Institutionalization 3: Whole Institution Approach for implementing sustainability DI 3 describes a Whole Institution Approach to sustainable development: All fields of action—research, teaching, service operations and campus management—as well as ecological, economic and social issues are addressed as balanced as possible and systematically related to each other. The main goal is an integration of different stakeholders, different topics and interests referring to sustainable development, including all faculties and science as well as administration.

Main differential between DI 2 and DI 3 is a profound coordination of the different fields of action for sustainability at HEIs and a clear structure of integrative implementation of activities. Information on sustainability issues is clustered within this comprehensive structure which is built to professionally foster the HEIs' sustainable development. Networks and cooperation for sustainable development are

stimulated and supported—at the HEI internally and beyond. Compared to DI 1 and 2, DI 3 represents a stronger forming of sustainability-institutionalization. DI 3 is similar to Leal Filho's (2015) institutional approach mentioned above, specifying further criteria of coordination and structure.

Exemplifying DI 3, the University of Hamburg (Universität Hamburg, UHH) may serve as a prototype description: At the UHH, the Center for a Sustainable University (Kompetenzzentrum Nachhaltige Universität, KNU) was established in 2011(see also Schneidewind and Singer-Brodowski 2013). The KNU brings together expertise from all areas and disciplines to focus on sustainability related issues in order to shape the UHH as a "Sustainable University". The KNU acts as a research network, a laboratory for innovation and an incubator for new approaches, concepts, procedures and methods in the context of sustainability. It accompanies and supports transformational processes at the UHH. The KNU includes all parts of the UHH (i.e. faculty, students, administration and operations) and implements transformational projects and methods at an organizational level. The UHH's sustainability activities are coordinated and systematically clustered there. Four reference dimensions for university-wide sustainability trigger the development of theoretical and practical perspectives on: (a) reflection on science (e.g. what does sustainability in science actually mean? Which system changes in science are necessary to achieve global sustainable development in the long run?), (b) research (e.g. how can sustainable development be defined and developed?), (c) didactic (e.g. what are the characteristics of sustainable education? And how can it be facilitated?) and (d) institutional (e.g. what is sustainable governance? How can sustainability-oriented operations be achieved?) (cf. Bassen et al. 2013). Five interdisciplinary teams and the coordinating office of the KNU support various aspects of sustainable development at the UHH and in society in general. The KNU not only initiates research projects regarding sustainability and sustainable development issues but also in cooperation with the student initiative oikos Hamburg e. V. works on UHH sustainability reporting processes, launches activities and events at campus, etc. Besides offering sustainability-related degree programs (e.g. Master of International Business and Sustainability), hosting specialized sustainability-related research centers (such as "CEN—Center for Earth System Research and Sustainability" and "Integrated Climate System Analysis and Prediction (CliSAP)") and addressing sustainable campus management issues (energy use, recycling, mobility), the UHH also increasingly takes care of professionalizing her sustainability-related organizational development, networking and internationalization. The KNU therefore operates using a Whole Institution Approach for sustainable development and contributes to an overall institutionalization of sustainable development within the UHH (see www.nachhaltige.uni-hamburg.de).

IV: Degree of Institutionalization 4: Sustainability-related organizational profile A clear-cut institutionalization of sustainability exceeding all the so far mentioned DIs is given, when a HEI explicitly and titular refers to sustainability as its mainly focused topic for research, teaching and operations: In cases like this, sustainability-related issues are integral part of the HEI's scientific and

organizational profile, not only incorporating sustainability as one topic amongst others but exclusively dealing with it. DI 4 marks sustainability as a unique and sole "selling point" of a HEI, leaving other research and teaching topics behind.

Exemplifying DI 4, the University of Applied Sciences for Sustainable Development in Eberswalde (HNEE) may serve as a prototype description: Sustainability is rooted in the name and organizational profile of HNEE. The one and only focus of HNEE is research, teaching and operations for sustainable development, offering degree programs such as "Forest Information Technology", "Regional Development and Nature Conservation" and "Sustainable Tourism". HNEE's mission is to research sustainable development, to teach, and to provide the society with the research results. With respect to students, its employees, cooperation partners, the economy, society and nature, it is responsible for teaching concrete concepts for sustainable actions as well as learning how to self-apply those concepts (see sustainability report of HNEE). HNEE is climate neutral and describes itself as greenest university of Germany (www.hnee.de). Since the HNEE is a University for Applied Sciences,[5] its' spotlight is on practical and application topics related to sustainable development.

4 Discussion

By suggesting these four different types of institutionalization for sustainability at HEIs, a theoretical systematization as well as a rough range of increasing sustainability-implementation is described. It serves as one possible operationalization-scheme for DIs related to sustainable development at HEIs: The DI is estimated according to information given within sustainability reports and websites about organizational structures related to sustainability. The authors used prototypical examples of single German HEIs to illustrate the DIs, which can be seen as an exploratory pragmatic approach rather than an in-depth empirical study. While working on the so far suggested categorizations, the authors of this paper generated the systematization pattern by iteratively defining and checking criteria for each DI. It should be noted, however, that although theoretical definitions and differentiations between the DIs can be made, empirically there might be cases that can't be consequently assigned to one of the DIs. Further research is necessary to evaluate objectivity, reliability and validity as well as practicability of the scheme and the DIs respectively.

Important to bear in mind is also the fact that by using the scheme and trying to estimate a HEI's DI—as a self-assessment tool, for example—no conclusion about the success of the considered sustainability activities and structure can be made. The scheme should mainly serve as a (self-)orientation pattern, not as an evaluation

[5]In Germany, a university and a university for applied science "Fachhochschule"/"Hochschule für Angewandte Wissenschaft" are comparable with the difference between universities and colleges in the United States.

method in general. It gives instructions on how to range degrees of institutionalization for sustainability at HEIs, thus allowing statements that refer to "more or less" of sustainability-institutionalization, but not as a measurement in the sense of scaling.

Moreover, the methodological approach, the systematization pattern (DI-scheme) and the selection of prototypes in this paper have to be discussed further: All of them need more empirical validation; neither the DIs nor the HEIs chosen as prototypical examples prove anything; other prototypes might have been chosen and other DIs identified in different contexts. The methodological approach presented in this paper is not exhaustive—because it was not conducted within a particular research project or ongoing study, but rather evolved as a "rapid model" from a vocational context of the authors—and should be elaborated in further papers.

To prevent misinterpretations concerning the suggested different degrees of sustainability-institutionalization, one should note that a "higher" degree is not necessarily identical with a "better" implementation of sustainability-related actions and structures: Each HEI has its own institutional history and might be more or less imprinted for institutionalizing sustainability. It has to be stated that (a) designing an organization's/HEI's institutional profile through sustainability (as represented in DI 4) is very different from the concern to integrate awareness and capacity for sustainable development issues into given and established structures in general (DIs 1–3). Whereas some HEIs might favor to exclusively focus all of their research, teaching, and operations on sustainability-related topics and activities—see as an example the HNE Eberswalde, a university that by now has 1979 students and 216 staff members; founded in 1992[6]—some other HEIs, as the UHH, for example (more than 40,000 students, round about 5000 staff members, founded in 1919), seek to keep their organizational identity as a "Volluniversität", incorporating many long established faculties and disciplines. HEIs like these might focus on processes how to appropriately address different member groups in order to integrate awareness and capacity for sustainability in all of its established structures and fields of action step by step and trying to keep up other topics and research specializations as well.

In sum, to achieve the UN's Sustainable Development Goals for 2030, all HEIs will have to adopt and care for the topic of sustainability, in one way or another. This means that the "baseline" for sustainability at HEIs will rise anyway. Sustainability concerns have to be integrated at each single HEI individually. But imagine all HEIs profiling exclusively for sustainability, leaving other topics and specialization aside. That wouldn't be useful for education in general and would reduce the type of diversity that is prevalent at universities and can't be cast aside.

Finally, the question might be posed if the suggested DIs—serving as a rough categorization pattern only—are sufficient to represent key institutionalization forms of sustainability at HEIs. Are four different "types of institutionalization" enough to appropriately differentiate HEIs and their individual processes towards

[6]Sassen et al. (2014) respectively to the date of foundation http://www.hnee.de/de/Hochschule/Portraet/Portraet-K292.htm [in 1992 the present HNE Eberwalde came out of the in 1830 founded *Höheren Forstlehranstalt*].

implementing sustainability? Probably not! This paper aims at fostering discussions at HEIs (and beyond)[7] about how to achieve structural transformations towards sustainability. It wants to offer new perspectives on how to operationalize the advancement of sustainable development at HEIs. Of course, these ideas and perspectives are only approximations to a yet evolving field of investigation. The authors of this paper want to stimulate further elaboration of the suggested scheme and don't claim it to be thorough yet. Based on the work for this paper as well as from the viewpoint of the authors practical experience in dealing with sustainability implementation at HEIs, considering additional factors for operationalizing DIs is recommended. The following characteristics might be taken into account:

- *size, location and individual history of the HEI (year of foundation; "traditions"; established HEI organizational culture)*: These factors might have an impact on "time to sustainability institutionalization" und thus influence a DI. More research is necessary to clear up empirical relations between DIs and specific organizational variables.
- *reactive versus proactive behavior*: Is the orientation towards implementing sustainability at the respective HEI triggered from the inside of the institution (proactive), e.g. because provost, students, professor, staff consider it to be a truly relevant topic? Or is it triggered by outside factors such as competition or official government regulations (reactive) (on this topic, cf. Ceulmans et al. 2015, for example)?
- *integrative versus exclusive attitude*: Is the transformation towards sustainability driven by an attitude of integrating different perspectives and thus pointing out the potential that lies within change? Is an openness to change part of the activities that mean to foster sustainability (inclusive)? Or is the transformation towards sustainability mainly seen as a trait for a selected elite only, driven by an attitude that excludes relevant stakeholders (exclusive)?
- *participation versus enforcement processes*: Does an HEI rely on participation processes which enables different groups to share their own perspective on sustainable development and to come up with their own ideas for generating a Whole Institution Approach of fostering sustainable development? Is collaboration seen as a core value for transformational processes (participatory)? Or is an orientation towards collaboration on sustainability topics ruled by regulations and enforced upon people within the structures of the HEI (enforcement) (on this topic, cf. Disterheft et al. 2015, for example)?
- *incentive trend versus virtue*: Why do HEIs increase their activities regarding sustainability issues? Is the main incentive for HEI (and its members respectively) the ongoing "trendiness" of this topic, accompanied by better fundraising

[7]A "sustainability self-assessment" for HEI, offered by Müller-Christ in „Hochschulen für eine nachhaltige Entwicklung – Ideen zur Institutionalisierung und Implementierung" (2013; S. 64–67) and in „Hochschulen für eine Nachhaltige Entwicklung. Nachhaltigkeit in Forschung, Lehre und Betrieb" (2011; S. 60–71), which should promote an internal discussion at HEIs about implementation and institutionalization of sustainability. Further provides this assessment a concept for an internal self-checking about the current situation of implementing sustainability.

possibilities and other extrinsic reasons (trend)? Or are HEIs (and their members respectively) motivated by intrinsic and pro-social reasons, e.g. because responsibility for future generations is perceived as important ("virtue")?

– *interpretation holistic versus isolated*: Is sustainability interpreted as a holistic notion that ties ecological, economic, social and cultural dimensions together and aims at illuminating their interconnections? Is it seen as a systemic and multi-perspective topic of transformation (holistic)? Or is sustainable development only interpreted from a single dimension or point of view (e.g. restricted to ecological aspects only) in an isolated way, thus suppressing relevant relations that need to be put in an all-together context (isolated) (on this topic, cf. Heinrichs and Laws 2014, for example)?

Although no further ideas about operationalizing the aforementioned characteristics can be presented here, combining these (binary) criteria with the four different DIs suggested in the section above as a matrix could help to more clearly specify occurrences of institutionalization of sustainability-related actions at HEIs. A matrix like this might be used as a detailed self-evaluation tool for HEIs and its results can serve as a baseline for distinct measures and methods to promote implementation and institutionalization of sustainability-related activities at HEIs.

Reflection processes concerned with sustainable development at HEIs might be established, dealing with questions such as: Do we want and are we able to become a university that is particularly focused on sustainability topics, thus fixing our organizational profile on sustainability? Do we want to face societal challenges in a reactive or proactive way? Should the attitude by doing this be rather integrative or exclusive? Are participation processes or enforcement processes more successful in the long run? Should incentives be trend- or virtue-driven? Do we interpret the notion of sustainability from a holistic or an isolated point of view?

Discussing questions like these in different settings at HEIs might help to trigger further research and action of how to implement and to institutionalize sustainability and sustainable development—in German HEIs and abroad.

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Appendix

(See Table 1).

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Promotion of Sustainable Development at Universities: The Adoption of Green Campus Strategies at the University of Southern Santa Catarina, Brazil

João Marcelo Pereira Ribeiro, Samuel Borges Barbosa, Jacir Leonir Casagrande, Simone Sehnem, Issa Ibrahim Berchin, Camilla Gomes da Silva, Ana Clara Medeiros da Silveira, Gabriel Alfredo Alves Zimmer, Rafael Ávila Faraco and José Baltazar Salgueirinho Osório de Andrade Guerra

Abstract

Universities, as knowledge institutions, play an important and strategic role on maximizing the social and economic benefits of new ideas. This paper aims to analyze the main sustainable practices of a Green Campus and subsequently points out the guidelines to implement a sustainable environmental management in the University of Southern Santa Catarina, Brazil, involving academic activities and the Campus infrastructure. The University of Southern Santa Catarina has been developing global partnerships encouraging the scientific production and sustainability practices to make it an example of Green Campus in South America.

Keywords

Green campus · Sustainable universities · Strategies · Sustainable development

J.M.P. Ribeiro (✉) · J.L. Casagrande · S. Sehnem · I.I. Berchin · C.G. da Silva · A.C.M. da Silveira · G.A.A. Zimmer · R.Á. Faraco · J.B.S.O. de Andrade Guerra
University of Southern Santa Catarina, Florianópolis, Brazil
e-mail: joaomarceloprdk@gmail.com

J.L. Casagrande
e-mail: jacir.casagrande@unisul.br

S. Sehnem
e-mail: simonesehnem_adm@yahoo.com.br

I.I. Berchin
e-mail: issaberchim@gmail.com

C.G. da Silva
e-mail: camila2527@gmail.com

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1 Introduction

Universities have frequently been regarded as key institutions in the process of social change and development (Brennan et al. 2004). During the last two decades, many universities have become involved in embedding sustainable development into their academic systems (Lozano et al. 2015). At the Stockholm Conference in 1972 (UNEP 1972), education was formally recognized on an international level to play an important role in fostering environmental protection and conservation (Lozano et al. 2015; Tan et al. 2014).

One of the action models for the promotion of sustainability in universities is through Green Campus (GC) initiatives. They are opportunities that allow the University to develop their structures with the aim of decreasing its negative environmental impacts, as well as to provide an environment that positively affects the social development, focusing on innovative actions directed to sustainable development.

University Campuses are major consumers of energy and resources, and generators of hazardous wastes (Roy et al. 2008). This causes direct and indirect environmental impacts through their activities—including the use of classrooms, laboratories, offices and services (Lukman et al. 2009).

The University of Southern Santa Catarina (UNISUL), located in Brazil, has among its objectives the greening of its campuses, in order to cope with sustainable development. This paper aims to analyze the main sustainable practices of a GC and subsequently points out the guidelines to implement a sustainable environmental management in UNISUL, Brazil, involving academic activities and the campus infrastructure.

The result of the research will support the University administrators, enabling them a better use of resources on the most important areas in a way that meets the principles of environmental sustainability.

A.C.M. da Silveira
e-mail: anaclaramed3iros@gmail.com

G.A.A. Zimmer
e-mail: gabriel.zimmer.br@gmail.com

R.Á. Faraco
e-mail: rafael.faraco@unisul.br

J.B.S.O. de Andrade Guerra
e-mail: baltazar.guerra@unisul.br

S.B. Barbosa
Universidade Federal de Santa Catarina, Florianópolis, Brazil
e-mail: osamuelbarbosa@gmail.com

2 The "Greening" of University Campuses

One way for universities to achieve sustainability is through initiatives that require implementing short-term activities with quick and visible results (Marinho et al. 2014). In this sense, the possibility of diversified alternatives of participatory democracy, particularly, the access to information and the consolidation of open channels for a plural participation within the university would be an example of action for sustainable development (Jacobi 2003).

Universities are usually an environmentally inefficient space (Patel and Patel 2012). Studies demonstrate how many resources are spent by universities and how this affects the environment and the society, however, alternatives and actions are presented to make universities more sustainable (Mason et al. 2003; Suwartha and Sari 2013; Tan et al. 2014; Chalfoun 2014).

These options presented by science are being used by universities in order to make their facilities "greener", focusing mainly on reducing energy demand in the production, hazardous waste on University Campuses, and promoting a curriculum aimed at sustainable development (Alshuwaikhat and Abubakar 2008; Roy et al. 2008).

For Saleh et al. (2011), the process of "Greening Campuses" focuses on sustainable initiatives, such as improving efficiency, protecting and restoring ecological systems and enhancing the well-being of all members of the campus. According to Hooi et al. (2012), this involves people, process and place. People would be related to employees, the campuses users and frequenters, the culture to which they belong and their well-being. Process involves the primary and secondary processes of the organization. Place involves all aspects of housing, deciding the location of the building, functional flexibility and technique.

In order to achieve the proposed objectives for the status of GC, Darus et al. (2009) suggest a better political, social, technological, economic and environmental system optimization, which relates to education, members issues, investment in research and technology and improvement of university infrastructure. According to Patel and Patel (2012), sustainable campuses are designed to reduce the overall impact of the built environment for the benefit of human health and the natural environment through: efficient use of energy, water and other resources, protecting members' health and improving employee productivity, reducing waste, pollution and environmental degradation.

At the Green Campus Strategy Document from Middle East Technical University Northern Cyprus Campus (2015), GC is a social responsibility initiative with actions planned, taking into consideration the notion of sustainability and environmental friendliness.

For Tereza Heinz, chairman of Heinz Family Foundation (Heinz Family Foundation 1995), GC is an initiative that conducts environmental audits of the campus, creates environmental purchasing policies, reduces campus waste, maximizes energy efficiency, implements sustainable land use, transportation and

building, as well as creates a student environment center and support those students interested in environmental responsible careers.

Several studies about sustainability in GC focus on the infrastructures of the university buildings and the social, environmental and economic impacts caused to the university (Mason et al. 2003; Darus et al. 2009; Tolley 1996; Lukman et al. 2009; Saleh et al. 2011; Olszak 2012; Saadatian et al. 2013; Chalfoun 2014; Katiliute and Daunoriene 2015). Thus, based in the Table 1, GC are defined as universities that may develop an infrastructure that provides the environment-university interaction in a sustainable way.

Furthermore, Universities must meet a sustainable development agenda and include in their curricula subjects related to sustainability. This would affect the culture within the society, providing the perpetuation of sustainable ideas (Roy et al. 2008).

Table 1 Green campus concepts

Authors	Concept
University of Western Sydney (2015)	The proposed University Western Sydney (UWS) Green Campus Framework, is related to the sustainable actions in the following areas: Buildings and Grounds, Purchasing, Dining Services, Academic Departments, Admin Offices and Classrooms, Labs, Research Facilities and Studios, Student Activities
US Environmental Protection Agency (2015)	According to the Greening Campus Project, GC is an educational space where their functions are in accordance to an environmental sustainability culture balancing its actual functions and future projects with available resources
UNEP (2013)	The Greening Universities Toolkit, UNEP (2013), states that GC initiatives are those which recognize the priority of sustainable issues by the Universities to promote the integration of sustainability concerns
International Alliance of Research Universities (2014)	The Green Guide for Universities is a document organized by the International Alliance of Research Universities (IARU) and states that Universities play an important role in creating a pathway for a sustainable world. The Universities are asked for training the world's future leaders and they are not, or should not to be, strongly tied to financial or political aspects. Thus, they are supposed to have freedom to develop and test solution to global challenges, as for example, create a more sustainable future
Tan et al. (2014)	The GC initiative in China, according to Tan et al. (2014), begun with the eco-technology demonstration and energy management practice with enforcement from the government, and with the demonstration of practical results more and more fields were covered on campus

2.1 The First Steps on Implementing a Green Campus at the University of Southern Santa Catarina

UNISUL, founded in 1964, is a community university established by the Municipal Government of Tubarão, Santa Catarina, Brazil. It aims to promote education, science, culture, sustainable community and social development with the creation and diffusion of technology, primarily in the region in which it is located, through a series of projects related to the growth and local capacity building, aiming a more sustainable future.

Prioritizing actions involving teaching, research and outreach, UNISUL facilitates the operation of the Environmental Education in different social centers, such as classrooms, virtual environments, administrative offices, and thus guarantees an important role as the coordinating agent of building proposals for the improvement and maintenance of environmental quality.

UNISUL, in its Institutional Development Plan (UNISUL 2015), has Sustainable Development as one of its premises, aiming to promote the institutional growth, ensuring the social and environmental balance with the economic and financial balance.

In order to receive the status of GC, UNISUL requires management tools that lead the university to prioritize its efforts and investments. One of these management tools is proposed in this paper, which uses the tree of multi-criteria analysis methodology with the dimensions and values properly adjusted in order to provide the University a safe way to turn into a GC.

3 Methodology

This paper used a multi-criteria analysis in order to identify indicators and create an assessment model to serve as a supportive decision tool for sustainable universities. According to this methodology, it will be possible to evaluate how much a university campus is close or far to be considered a GC.

The multi-criteria methodology is part of the Operational Research (OR) area and was first employed in decision making in complex situations, with a large number of factors involved (Bell et al. 1988; Bana e Costa et al. 2000). Unlike traditional methods of OR optimization, which seek to define the best alternative in an analysis, the multi-criteria assessment aims to understand all the aspects involved in the decision making in complex situations (Clemen 1996).

In this research, the authors selected scientific journals and documents in the area of sustainable universities and conducted a literature review and a subsequent choice of indicators to reach a comparative table. The basic criterion to include an indicator was its citation in at least three articles published by different authors and from two distinguished scientific journals.

Table 2 Renewable energy indicators

Authors	Indicator/justification
Alshuwaikhat and Abubakar (2008)	Use of wind, solar and geothermal sources for heat and power, low-flow faucets, showerheads, and toilets and day lighting to illuminate classrooms which offers dramatic reductions in buildings operations and maintenance costs
Massachusetts Executive Office of Energy and Environmental Affairs (2008)	In an effort to reduce the large amount of energy currently generated from non-renewable resources, universities are increasingly turning to renewable energy resources such as wind, solar, and biomass
Princeton University (2015)	The campus will soon benefit from aggressive research into zero- or low-carbon energy sources such as geothermal, biodiesel from sustainable sources, and solar electric power
Faghihimani (2010)	The issue of energy is usually thought of reducing the consumption of fossil fuels and replacing it by renewable energy
Directorate of Technical Education Madhya Pradesh (2013)	Greening the campus is all about sweeping away wasteful inefficiencies and using conventional sources of energies for its daily power needs, correct disposal handling, purchase of environment friendly supplies and effective recycling programme

Renewable energy is an urgent need to maintain the current society and future generations (Andrade Guerra et al. 2014; Evans et al. 2009; Dell and Rand 2001; Rader and Norgaard 1996). According to Table 2, Universities are laboratories that allow the development of studies and research on the subject. At the same time, they can provide a lower cost to the institutions, transforming it into a supplier and not a consumer.

Energy efficiency (Table 3) means to achieve the best performance in the production of a service with the lowest energy expenditure (Andrade Guerra et al. 2014; Patterson 1996; Phylipsen 2010; Ang 2006).

Following the concept of energy efficiency, water efficiency consists in achieving the best performance in the use of water resources, saving and re-using water (United Nations 2014; Mastrorilli et al. 1995; Water 2004; Armstrong 2006). Table 4 presents the alternatives of how to make universities more efficient in the use of water, and actions to modernize the equipment and processes to reduce consumption and re-use water.

An efficient and sustainable transportation system is essential for the economic and social development of cities and consequently of universities (Table 5). Vehicles generate emissions, congestion and accidents, and the path to the university collaborates with the increase of these numbers (Andrade Guerra et al. 2015; Steg and Gifford 2005; Gudmundsson and Höjer 1996).

Table 3 Energy efficiency indicators

Author	Indicator/justification
Alshuwaikhat and Abubakar (2008)	The target of the energy-efficient green buildings is to improve the lighting, temperature control, and the ventilation and indoor air quality, which contribute to healthy environments by reducing the dangerous air-pollutants that cause respiratory disease in campus buildings
Massachusetts Executive Office of Energy and Environmental Affairs (2008)	In order to reduce the energy consumption, the campuses may implement energy efficiency upgrades, employ awareness strategies around the energy usage, and behavior-changing tactics that offer the opportunity for increased the student and community member involvement
Minnesota State University (2010)	The project presents a view of energy efficiency through the creation and adaptation of nationally recognized programmes that serve to conserve energy, educate students and generate renewable energy
Princeton University (2015)	The first step toward curbing the emissions is conserving the energy resources currently used by the university
Faghihimani (2010)	Energy efficiency, environmentally friendly materials/design and systems, the implementation of innovative systems in order to conserve the resources, heating and lighting systems, health issues, obtaining standard certificates
Tan et al. (2014)	Energy conservation is the core of the energy and resource efficient campus, and hence to make the construction and operation of campus infrastructure energy efficient is the key point of the energy and resource efficient campus
International Alliance of Research Universities (2014)	20 % reduction of CO2 emissions and energy consumption in the university
Directorate of Technical Education Madhya Pradesh (2013)	Raise campus awareness about the need for energy conservation and provide incentives for action, such as by establishing campus-wide "Eco-olympics" competitions

The way in which the process of disposing, collection, treatment and final disposal of waste is made affects the lives of the entire community therefore; this issue becomes a concern of the university, society and governments (Table 6). The maintenance of household waste is critical to ecological balance, and requires effective action by governments in order to be fulfilled.

Education is the key to sustainability on university campuses. It requires teaching and learning group actions to motivate and empower students, employees and campus members to change their behavior and take action for the sustainable development (Table 7). The Education for Sustainable Development promotes—

Table 4 Water efficiency indicators

Author	Indicator/justification
Alshuwaikhat and Abubakar (2008)	Water conservation can be achieved via the collection of rainwater and stormwater for irrigation, and design landscapes with drought-resistant native plants and grasses
Massachusetts Executive Office of Energy and Environmental Affairs (2008)	To tackle climate change and the decline of freshwater resources availability, campuses are conserving water and promoting low impact development (LID) by implementing initiatives that reduce impervious surfaces and the energy needed to supply water
Princeton University (2015)	The Campus Plan identifies stormwater management as one of the most critical and strategic means to promote campus sustainability. The proposed landscape-based approach to stormwater management relies on bio-engineered techniques rather than hard infrastructure that disturbs the landscape
Faghihimani (2010)	Installing appropriate equipment to conserve water, efficient water waste systems, initiating movement to change consumer behavior (p. 10)
International Alliance Of Research Universities (2014)	Establishing campus landscape designs that highlight water conservation or biodiversity
Directorate of Technical Education Madhya Pradesh (2013)	Wastewater Management/Rainwater harvesting. Every institute has to work in the direction of wastewater management particularly in student's hostels

Table 5 Efficient transportation indicators

Author	Indicator/justification
Alshuwaikhat and Abubakar (2008)	Green transportation system through encouraging the use of bicycles within campuses and providing access to public transportation to all staff, students and visitors, and discouraging the use of single-car to employee commuting can also reduce the emission and congestion
Massachusetts Executive Office of Energy and Environmental Affairs (2008)	In an effort to reduce greenhouse gas emissions from student, faculty, and university vehicles, campuses are implementing innovative methods to reduce vehicle fuel usage
Princeton University (2015)	The commitment with a sustainable transportation infrastructure will affect not only the quality of the campus environment, but also of the region
Faghihimani (2010)	Cutting the carbon footprint by promoting walking, cycling, public transportation, electric cars and carpool
Heinz Family Foundation (1995)	In transportation plans, provide incentives for walking, bicycles, buses or rail, and ridesharing

reflecting on future scenarios—critical thinking and decision making based on the science of sustainability (Warburton 2003).

4 Multi-criteria Assessment Tree for Green Campus

The Universities are considered a GC when comprises the six main factors: renewable energy, energy efficiency, hydro efficiency, transport efficiency, waste management and education, according to Tables 2, 3, 4, 5, 6 and 7. Each of these key factors was divided into secondary factors, according to the review of scientific literature.

Table 6 Waste maintenance indicators

Author	Indicator/justification
Alshuwaikhat and Abubakar (2008)	Recycling systems that encourage the contractors to recycle in constructing buildings and facilitate staff and student recycling helps conserve the resources
Massachusetts Executive Office of Energy and Environmental Affairs (2008)	Colleges and Universities are implementing waste prevention and recycling programmes that offer significant potential for decreasing greenhouse gas emissions
Princeton University (2015)	Strategies to increase the recycling rates include the introduction of more uniform and visible labeling for all containers, expanding receptacle locations, and augmenting year-end recycling services for student move-out
Faghihimani (2010)	Refers to the developing waste management system, any systematic form of waste fraction, the re-use of waste for other purposes (heating and compost), the safe disposal of electronic devices (WEEE) and chemical substances
Akpan et al. (2003)	Waste reduction must start with the knowledge about the need for reducing materials use, then revising material and recycling as a third step
International Alliance Of Research Universities (2014)	All sustainable waste management programmes should include strategies for re-using materials, including furniture, books, computer and lab equipments
Heinz Family Foundation (1995)	Establish a programme to reduce, re-use, recycle, and compost a high percentage of campus waste. Increase the percentage reduced, re-used, recycled, and composted annually

Table 7 Education indicators

Author	Indicator/justification
Massachusetts Executive Office of Energy and Environmental Affairs (2008)	To help increase the energy conservation inside and outside the campus, the campuses are discovering innovative ways of increasing environmental and energy awareness and incorporating sustainability into the *curricula*
Princeton University (2015)	Princeton's conservation programmes are benefited an additional programmatic support provided by many student educational initiatives such as "Pull the Plug", a programme encouraging the students to turn off all sources of power in their rooms when leaving for breaks
Humblet et al. (2010)	Education and training are critical to providing continuity and long-term success of an institution's GC plan. Sustainability is not a one-time endeavor, but a continuously ongoing pursuit to improve efforts
Heinz Family Foundation (1995)	Integrate environmental knowledge into courses in all relevant disciplines
Valencia College (2011)	Start interdisciplinary programme focused on sustainability. Create a programme that incorporates subjects such as permaculture, bio-intensive gardening, aquaculture, hydroponics

After establishing the factors that determine a GC, their relative values were established. These values were determined querying sustainability experts from several countries, including the United Kingdom, India, Italy, Cabo Verde, Chile, Germany and Brazil. Seventeen experts were consulted.

The Green Campus Multi-criteria Tree importance scales defined in a percentage for each factor, as seen in Fig. 1.

According to Fig. 1, it is possible to understand the factors that assume more importance in determining a GC. The Energy Efficiency and Education factors were considered by the experts the most important. Among the secondary factors, it is also possible to analyze the highest and lowest value. The Energy Conservation Programmes factor was considered of greatest importance, representing an overall value of 6.6 %. This value can be obtained by multiplying the percentage of Energy Conservation Programs (35.7 %) by Energy Efficiency (17.8 %). On the other hand, the Zero Paper Programme factor was considered of lowest importance obtaining an overall value of 2 %. This value can be obtained by multiplying the percentage of Zero Paper Program (11.8 %) by waste management (17.1 %). Thereby is possible to calculate de absolute value of each factor.

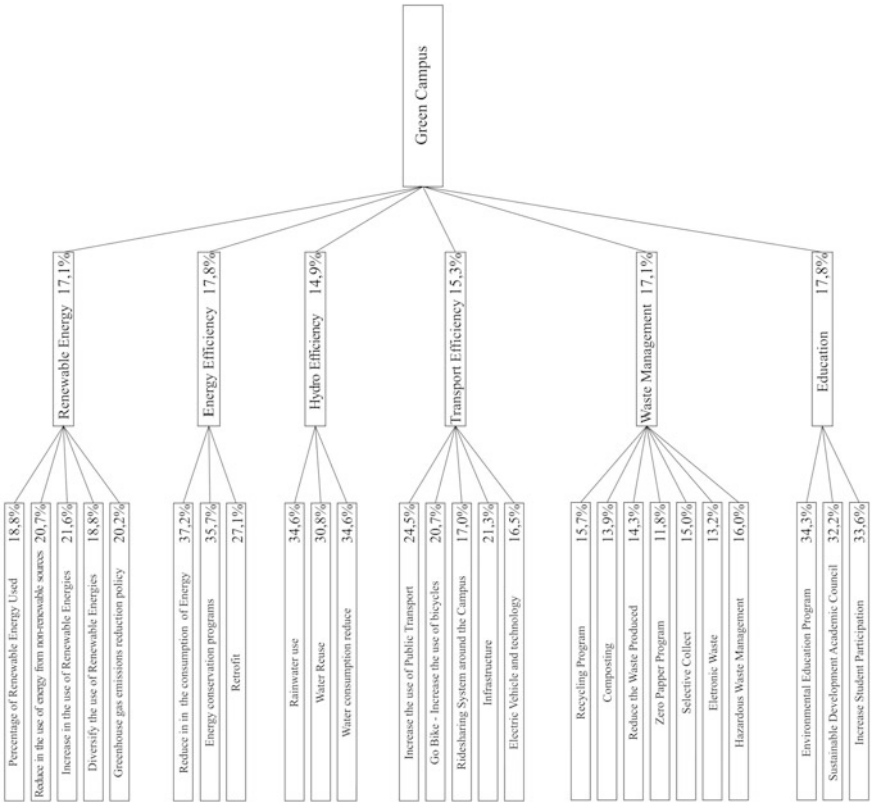

Fig. 1 Green campus multi-criteria tree and weights

5 Final Considerations

Currently, the challenges faced by universities leads them to pursue development according to sustainability principles, respecting the environmental, social and economic aspects. Universities, as educational institutions involved by large amounts of human and financial resources, can serve as a model for the sustainable development and creation of a new environmental and social awareness.

Generally, the authors stated that GC is an implanted and experienced culture on college campuses to promote the awareness about local and global environmental sustainability. Among the initiatives planned in the GC programmes, the Energy Efficiency Actions, Renewable Energies, Water Efficiency, Efficiency in Transportation, Waste Management, and Environmental Education Programmes were highlighted.

These actions allow us to conclude that universities should have investment lines to improve the areas of energy, water use, transport, waste and environmental education. These five pillars define the bases of sustainability in the contemporary universities.

The assessment model developed in this paper allows to understand the relative importance of each indicator. This model can be understood as a new view for the universities, presenting the areas in which the institution should invest its resources.

The model proposed in this study will help UNISUL to establish investment priorities, in order to convert the university into a GC. As previously stated, UNISUL defines sustainability as one of its strategic goals, however a systemic plan of action is essential. This planning may be oriented using the model presented in this study.

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Authors Biography

João Marcelo Pereira Ribeiro Master's student in Administration at University of Southern Santa Catarina, Brazil. Researcher at projects LINKS 2015 and BRIDGE, funded by FAPESC and the Research Council of United Kingdom (RCUK) through Newton Fund. Researcher at Group on Energy Efficiency and Sustainability—GREENS. E-mail: joaomarceloprdk@gmail.com.

Samuel Borges Barbosa Ph.D. in Production Engineering at Federal University of Santa Catarina. Researcher at Group on Energy Efficiency and Sustainability—GREENS. E-mail: samuelibia@yahoo.com.br.

Jacir Leonir Casagrande Ph.D. in Production Engineering at Federal University of Santa Catarina (2002). Professor at the University of Southern Santa Catarina. E-mail: jacir.unisul@gmail.com.

Simone Sehnem Ph.D. in Tourism and Management at University of Vale do Itajaí (2011). Professor at the University of Southern Santa Catarina. E-mail: simonesehnem_adm@yahoo.com.br.

Issa Ibrahim Berchin Master's student in Administration at University of Southern Santa Catarina, Brazil. In Unisul he is a researcher at the Research Group on Energy Efficiency and Sustainability—GREENS. He also participates in the projects LINKS 2015 and BRIDGE, funded by FAPESC and the Research Council of United Kingdom (RCUK) through Newton Fund. At Unisul, he was a junior research in REGSA Project, Brazil. E-mail: issaberchim@gmail.com.

Camilla Gomes da Silva Bachelor's in International Relations at the University of Southern Santa Catarina. She also participates in the projects LINKS 2015 and BRIDGE, funded by FAPESC and the Research Council of United Kingdom (RCUK) through Newton Fund. E-mail: camila2527@gmail.com.

Ana Clara Medeiros da Silveira Bachelor in International Relations at the University of Southern Santa Catarina. E-mail: anaclaramed3iros@gmail.com.

Gabriel Alfredo Alves Zimmer Bachelor's in International Relations at the University of Southern Santa Catarina. He also participates in the projects LINKS 2015 and BRIDGE, funded by FAPESC and the Research Council of United Kingdom (RCUK) through Newton Fund. E-mail: gabriel.zimmer.br@gmail.com.

Rafael Ávila Faraco Ph.D. in Production Engineering at Federal University of Santa Catarina (2003). Professor at the University of Southern Santa Catarina. Assistant Coordinator of the project LINKS 2015 and BRIDGE, funded by FAPESC (Brazil) and the RCUK (UK). E-mail: rafael.faraco33@gmail.com.

José Baltazar Salgueirinho Osório de Andrade Guerra Ph.D. in Political Science and International Relations. Professor in the University of Southern Santa Catarina (Unisul). Also in UNISUL, he coordinates three research projects: JELARE and REGSA, both funded by the European Union; Projects LINKS 2015 and BRIDGE, funded by FAPESC and the Research Council of United Kingdom (RCUK) trough Newton Fund. Leader of the Research Group in Energy Efficiency and Sustainability. He was a member of the Scientific Committee of the World Symposium on Sustainable Development in Universities (WSSD-U-2012 and WSSD-U-2014), a parallel event to Rio + 20 and the Green Campus Summit 2013. E-mail: baltazar.guerra@Unisul.br.